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THE NAIL-HOLDING POWER OF THE PRINCIPAL PHILIPPINE COMMERCIAL WOODS [1]

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TWO PLATES AND ONE TEXT FIGURE

INTRODUCTION

It is common knowledge that it is harder to drive nails into, and harder to pull nails out of, certain species of woods than others. Furthermore, it is a well-known fact among wood carpenters that a denser or heavier wood holds the nail better and more securely than the ordinary softer variety. It is, however, also true that a harder wood cracks more easily than a softer one; the latter, in general, being able to take a larger number of nails than the former without any sign of splitting. This property of certain species of wood to hold nails better than others is of great importance in box making, crating, and framing. Wooden structures are usually fastened by means of nails, and in the absence of a knowledge or even a rough estimate of the comparative nail-holding power of the woods a rule of thumb is generally adopted, obviously without any scientific basis.

In an effort to find a basis of comparison regarding the relative holding power of some of the commercially important species of Philippine woods, specimens were subjected to a pulling test, which for this purpose may be called the direct-pull test. The

[1] This work was done in coöperation with the Bureau of Forestry, Ranger Martin Lagrimas assisting.

device allowed reading of the load for every 0.004 of an inch displacement while the pulling was in progress. A table of comparison was prepared from the average results of the nail-holding power of the species; and taking red lauan, or Philippine mahogany, as a basis, the different species were given their corresponding percentage values.

METHOD OF TEST

The tests were made in the following manner. Air-dry specimens 2 inches by 2 inches by 15 inches were prepared and three 6d wire nails were driven into each, one in the center and one about 3 inches from each end, so that 1.5 inches of the length of the nail was embedded in the wood. Care was taken that no appreciable splitting occurred while the nails were being driven. Nails were driven without special attention as to whether they were tangential or radial with respect to the grain of the wood, since in practice such conditions are present. An average value was computed from all the tests for each species. The nailed specimens were then laid aside in a dry place so that no appreciable amount of rusting might occur and tests were started immediately thereafter. It is evident that rusting would increase the resistance to pull.

The apparatus is set as shown in the illustration, Plate 1, with the specimen, S, in place. The nail puller indicated by the letter P is a steel rod bent at one end with a V-shaped slit, in the same fashion as the nail puller on the ordinary hammer. It carries a micrometer head, M, on a brass sleeve which can be fixed at any place on the puller by means of a set screw. A copper wire is soldered to this sleeve and connected to a buzzer, which in turn is connected to one pole of a dry battery B. C is a brass contact sheet with a wire lead to the other pole. This brass sheet is attached rigidly to the specimen by means of two screws.

The micrometer head M is raised 0.004 inch and the nail gradually pulled until contact is established and the load recorded. Immediately, the micrometer head is again raised 0.004 inch and the load again read when the buzzer sounds, and so on until the nail no longer offers resistance to pull. In this way each progressive load is taken for every 0.004 inch displacement of the nail head with respect to the specimen, up to the maximum load. When a sudden drop in resistance is noted the loads are again taken for every 0.008 inch displacement.

RESULTS OF TEST

A load-displacement graph was made for each species and an average curve was drawn through the points. Text fig. 1 represents the curve for red lauan, *Shorea negrosensis* Foxworthy. The curves for the other species run in a similar fashion; that is, the load increases steeply to a certain limit and then drops abruptly and follows a flatter curve towards the end. Plate 2 is a combined graph of all the species' curves showing the maximum resistance to pull as well as the relative steepness of the increasing loads.

Table 1 shows the species tested, grouped in the order of their maximum resistance to pull.

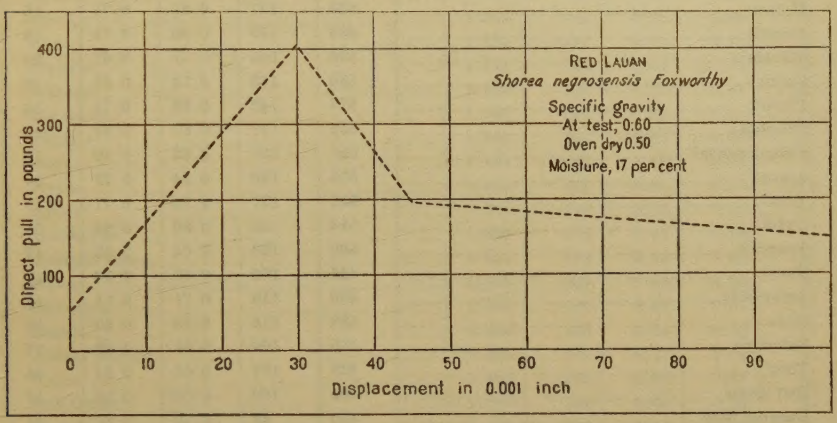

FIG. 1. Graph showing the nail-holding power of red lauan, *Shorea negrosensis* Foxworthy.

In Table 2 the species are arranged in the order of the slope of the curve up to the maximum resistance. The second column gives the value of tan α as shown in the graphs. This third column gives the ratio numbers corresponding to tangent α, the value for red lauan being 100.

DISCUSSION OF RESULTS

A graphical comparison of the nail-holding power of the different species tested (Plate 2) places pagatpat at the head of the list. An examination of the driven nail, however, showed considerable rusting which can be explained by the fact that pagatpat contains a high percentage of common salt, sodium chloride. When using this wood it is the practice to fasten the pieces together with copper or brass nails which are less at-

TABLE 1.—*Species arranged in the order of maximum resistance to direct pull.*

Common name.	Maximum resistance to pull.	Ratio number taking 100 as red lauan value.	Specific gravity.		Moisture content.
			At test.	Oven dry.	
	Lbs.				*P. ct.*
Pagatpat	840	207	0.75	0.64	18
Lamog	760	188	0.90	0.77	17
Manggachapui	745	184	0.79	0.69	15
Supa	680	168	0.79	0.68	16
Akle	655	162	0.69	0.58	19
Narra	650	161	0.65	0.57	14
Akleng parang	647	160	0.71	0.61	16
Molave	635	157	0.81	0.71	15
Amugis	620	153	0.89	0.75	18
Malugai	590	146	0.71	0.61	16
Banuyo	580	143	0.72	0.60	19
Tindalo	575	142	0.86	0.75	14
Pahutan	555	137	0.67	0.57	19
Kalamansanai	550	136	0.83	0.70	18
Aranga	535	132	0.84	0.72	17
Yacal	515	127	0.90	0.77	17
Guijo	510	126	0.80	0.66	21
Tanguile	500	123	0.64	0.55	17
Bayok	485	120	0.58	0.50	17
Amamanit	480	118	0.71	0.61	18
Nato	480	118	0.59	0.50	17
Palosapis	440	109	0.61	0.52	17
Toog	435	107	0.64	0.54	18
Red lauan	405	100	0.60	0.51	17
Benguet pine	400	99	0.73	0.60	21
Batete	343	85	0.60	0.51	19
Almon	313	77	0.70	0.60	16
Kalunti	300	74	0.68	0.58	17
Lumbayao	297	73	0.47	0.40	18
Apitong	285	70	0.73	0.62	17
Mayapis	270	67	0.41	0.34	20

tacked by salt. Pagatpat should, therefore, be treated separately in the discussion.

Lamog, manggachapui, supa, akle, narra, akleng parang, molave, and so forth, follow in the order of maximum resistance to pull. It may be noted that these species are high in oven-dry specific gravity, in the order of 0.57 to 0.75.

Mayapis, apitong, lumbayao, kalunti, almon, batete, Benguet pine, and red lauan have much lower resistance to pull, their oven-dry specific gravity being correspondingly lower, in the order of 0.34 to 0.62.

TABLE 2.—*Species arranged in the order of the slope of the curves up to the maximum resistance as shown in fig. 2.*

Common name.	Tan α.	Ratio number corresponding to tan α.	Specific gravity.		Moisture content.
			At test.	Oven dry.	
					P. ct.
Pagatpat	1.975	167	0.75	0.64	18
Manggachapui	1.904	161	0.79	0.69	15
Aranga	1.865	158	0.84	0.72	17
Molave	1.800	152	0.81	0.71	15
Kalamansanai	1.724	146	0.83	0.70	18
Amamanit	1.686	143	0.71	0.61	18
Batete	1.639	139	0.60	0.51	19
Banuyo	1.582	134	0.72	0.60	19
Akle	1.551	131	0.69	0.58	19
Amugis	1.541	130	0.89	0.75	18
Malugai	1.500	127	0.71	0.61	16
Palosapis	1.500	127	0.61	0.52	17
Tindalo	1.458	123	0.86	0.75	14
Supa	1.448	122	0.79	0.68	16
Narra	1.446	122	0.65	0.57	14
Lamog	1.340	113	0.90	0.77	17
Lumbayao	1.351	114	0.47	0.40	18
Benguet pine	1.321	112	0.73	0.60	21
Nato	1.265	107	0.59	0.50	17
Pahutan	1.247	105	0.67	0.57	19
Bayok	1.243	105	0.58	0.50	17
Akleng parang	1.200	101	0.71	0.61	16
Yacal	1.192	101	0.90	0.77	17
Red lauan	1.183	100	0.60	0.51	17
Tangile	1.183	100	0.64	0.55	17
Toog	1.167	99	0.64	0.54	18
Guijo	1.095	93	0.80	0.66	21
Apitong	1.093	92	0.73	0.62	17
Mayapis	1.048	87	0.41	0.34	20
Almon	0.981	83	0.70	0.60	16
Kalunti	0.850	72	0.68	0.58	17

It may also be noted that while yacal, tindalo, amugis, and aranga have high specific gravities—in the order of 0.72 to 0.77—they do not occupy as high a place as manggachapui, the specific gravity of which is 0.69. It seems that the only possible explanation of this variation is the inherent physical structure of the wood itself. Yacal, for example, is easily split and while splitting may not be discernible to the eye during the tests, it is quite possible that the fibers may have been separated in such a way as to give the low figures characteristic of this phenomenon.

Table 1 gives the species arranged in the order of maximum resistance to pull as shown in the graphs.

Table 2 gives the species arranged in the order of the slope of the curves up to the maximum resistance. There seems to be no definite relation between the slope of a curve and the specific gravity of a given species. In other words, it may take a greater pull to displace the nail a unit distance in the case of a species with low specific gravity than in the case of a species with a higher specific gravity. This fact seems to be contrary to what one may generally believe, but it is obvious that the slope has absolutely no relation to the maximum resistance.

CONCLUSION

The results of the test show that it is safe to assume that the nail-holding power of Philippine woods is closely related to the specific gravity; that is, the denser the wood the higher the nail-holding power.

The amount of displacement due to a unit pull was found to have no relation to the specific gravity.

Among the important species of high nail-holding power special mention may be made of manggachapui, which is already well known for its good qualities as flooring material.

ILLUSTRATIONS

PLATE 1

Apparatus for testing nail-holding power of wood. S, specimen; N, one of the three nails driven in the specimen, the middle nail is under test; M, micrometer head; C, brass contact sheet; P, nail puller; H, testing-machine head support; B, dry batteries and buzzer unit.

PLATE 2

Graph showing load-displacement curves of the species tested.

TEXT FIGURE

FIG. 1. Graph showing the nail-holding power of red lauan, *Shorea negrosensis* Foxworthy.

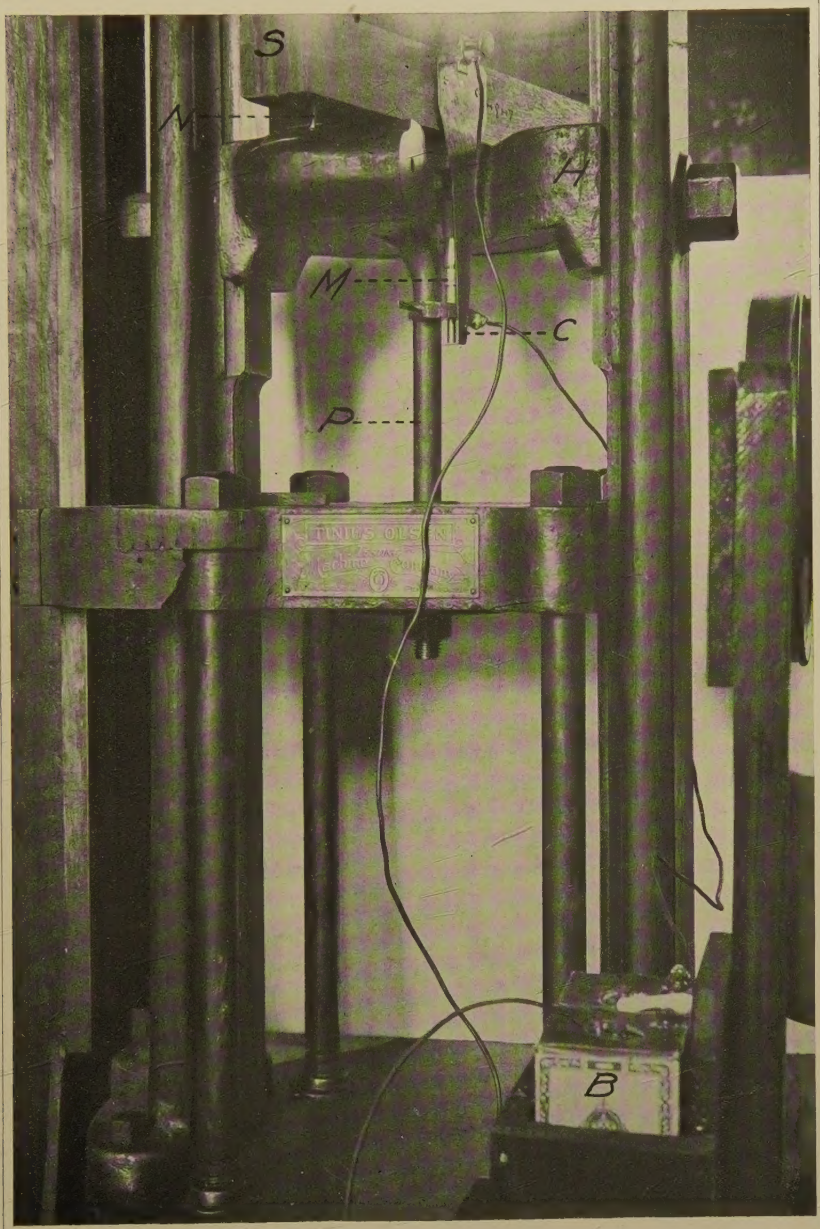

PLATE 1.

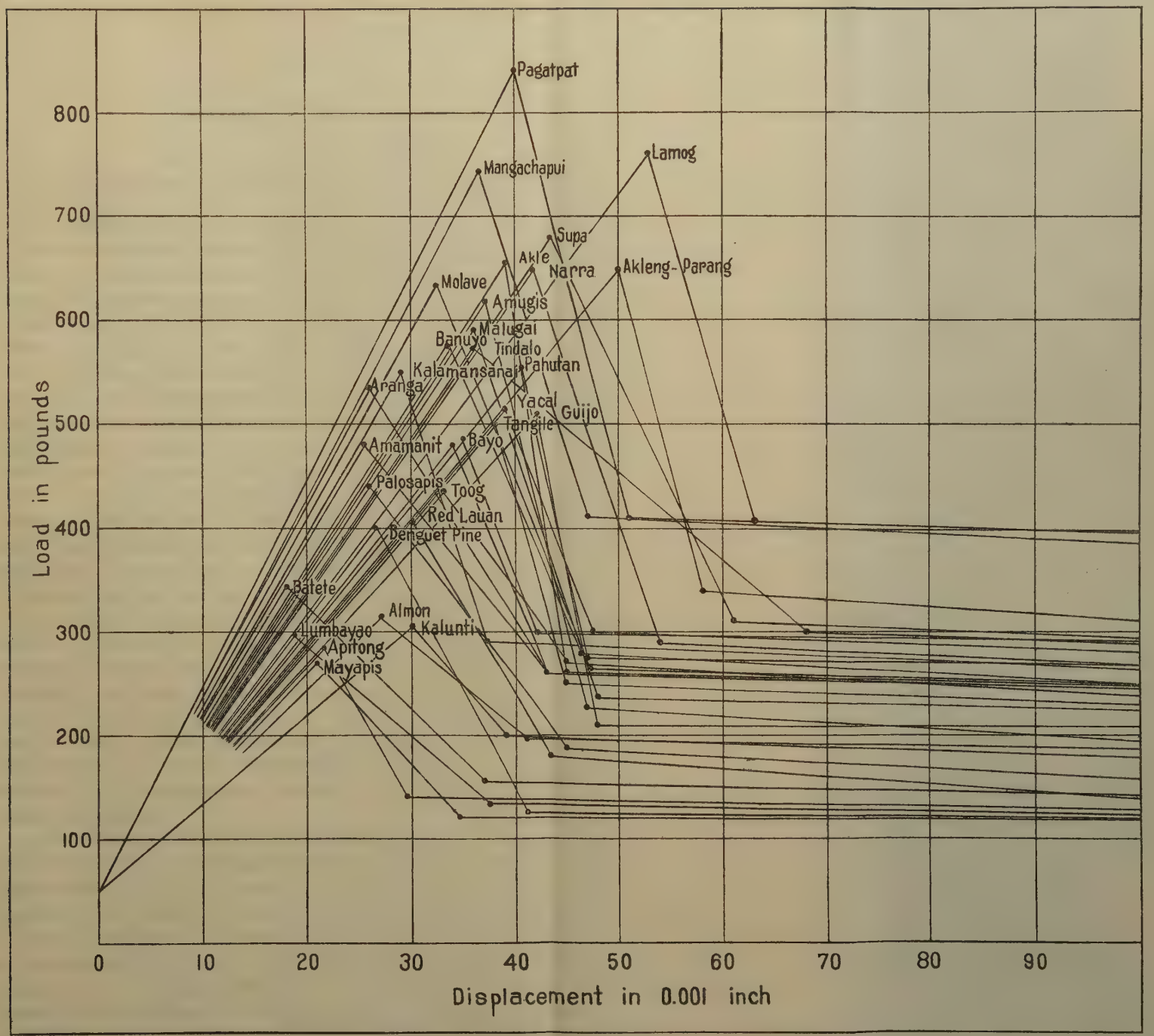

PLATE 2. GRAPH SHOWING LOAD-DISPLACEMENT CURVES OF THE SPECIES TESTED.

ANTIMOSQUITO SPRAYS

By R. L. Holt and J. H. Kintner

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The least that can be charged against the mosquito in its contact with higher animals, including man, is that it is a nuisance. In addition thereto, these insects are a serious menace in many parts of the world due to their ability to infect with malaria, dengue, yellow fever, and filariasis. The control of these infections depends on the control of the mosquito population and the prevention of their infection by allowing access to cases and carriers of the diseases mentioned. Everyone knows that the ideal situation would be achieved if mosquito breeding could be completely eliminated with consequent disappearance of these insects from the earth. This has been the dream of many men, but its practical accomplishment is not possible at the present time and one doubts if it ever will be a reality. Since this is true, it behooves us to see to it that breeding in or near human habitation is prevented or curtailed and that infection of mosquitoes is kept at the lowest rate possible, by screening cases or carriers while they are infective. The world over, these factors can be controlled to a limited extent only, due to ignorance, carelessness, indifference, and opposition for opposition's sake. Strangely, we have types of animals in human form who are opposed to anything suggested by the so-called "Medical Trust" for no other reason than that the suggestion comes from a medical source. Such mental cases are hopeless, and our only recourse is to arouse public opinion in such manner as to force their coöperation.

In the Philippine Islands, mosquitoes breed more or less freely at all elevations, particularly below 1,500 feet, and the conditions are such that they breed in profusion in most places. The continual hot climate, the heavy rainfall, and the limited finances of the Government, all help to make mosquitoes more or less of a general nuisance in this Archipelago. *Culex*, *Aëdes*, and/or *Anopheles* are highly prevalent in many places. As a result malaria and dengue are common and constant companions of thousands of the population. The only reason that yellow fever

is not a scourge comparable to those in Europe in the Middle Ages is that, by chance, no case of yellow fever has been imported into the Islands. In the event that yellow fever ever does come to these shores, it will be a calamity beyond our comprehension.

In Manila the principal infection spread by mosquitoes is dengue and, since the native population is almost, if not completely, immune, its effects are noted exclusively among nonnatives such as tourists, Army and Navy white personnel, and foreigners resident in Manila. Mosquitoes are no less a nuisance to the native than to the foreigner. While the health authorities, both native and American, do what they can to prevent mosquito breeding, what they actually accomplish falls far short of the ideal. Lack of sufficient funds and indifference to or ignorance in sanitary matters are insurmountable difficulties at the present time.

As a result of the nuisance caused by swarms of mosquitoes and the high prevalence of dengue, it was considered well worth while to attempt to develop an efficient spray to destroy the adult mosquito in homes and hospital wards especially.

It is well known that commercial preparations of this sort have a very low degree of efficiency insofar as killing the insect is concerned. They have a certain amount of repelling power. One commercial preparation bearing a well-known name will bring down many of the insects, but they recover from its effects in most cases. Some of them seem to require that the insect be drowned by the liquid. Certainly they have little other effect.

The problem to be solved was to find a preparation which would kill mosquitoes under such conditions that it could be applied practically to large indoor areas, such as hospital wards, and at the same time result in little or no toxic effects on patients. In addition, fire hazards and damage to linens and draperies had to be taken into consideration. Toxicity was determined in all cases by the effect on personnel present and on white mice exposed in the area in which the spray was applied.

The apparatus used was an air compressor driven by an electric motor and developing 60 pounds pressure. This air pressure was applied to a paint-spray apparatus extension to allow the spray to be set loose near the ceiling. The spraying apparatus was adjusted so that it delivered the spray as a fine mist resembling steam. In this manner the entire ceiling of

the room was covered and the spray allowed to "settle out" for one hour. Electric fans were stopped, and if a breeze was present the windows on the side from which it came were closed. Otherwise all windows and doors were left open. The preliminary work was done in a room containing 1,500 cubic feet. Of the 490 square feet of wall area, 50 square feet was taken up by windows which were simply openings in the wall covered by screening. The room was made mosquito proof by the use of 20-mesh netting. The floor was covered with white paper to facilitate collection of the dead insects.

The first mixture tried had the following formula:

Oil of eucalyptus	9
Methyl salicylate (synthetic)	18
Oil of citronella	50
Kerosene (purest quality) q. s.	1,000

One hundred *Aëdes ægypti* were liberated and a five-minute period allowed for them to disperse. Five hundred cubic centimeters of the mixture was sprayed near the ceiling, care being exercised to prevent the spray coming in contact with the insects as it emerged from the spray nozzle. This 1 cubic centimeter for each 3 cubic feet produced a fairly heavy mist in the room, which cleared slowly by falling to the floor and passing through the open windows. Both men and mice suffered moderate toxic effects. At the end of one hour twelve insects were picked up and at the end of the second hour four additional ones were collected. At the third hour no insects were found. Two of the sixteen recovered in twenty-four hours. The efficiency of this mixture in toxic concentration can be rated at only about 14 per cent.

The second formula tried was as follows:

Carbon tetrachloride	12.5
Methyl salicylate (synthetic)	25
Naphthaline	30
Kerosene, q. s.	1,000

Exactly the same conditions prevailed as in the previous experiment. Fifty cubic centimeters of the spray, or 1 cubic centimeter for each 30 cubic feet of air space, was liberated when toxic symptoms were noted both in the personnel applying the spray and in the control animals. In this concentration nine insects were collected the first hour and four the second. None recovered in twenty-four hours. The efficiency can be rated at about 13 per cent in toxic concentration.

The third mixture was as follows:

Methyl salicylate (synthetic)	25
Pyrethrum powdered (fresh)	60
Kerosene, q. s.	1,000

This mixture of pyrethrum and kerosene was shaken frequently over a period of two hours and filtered. To the filtrate was added the methyl salicylate. Under the same conditions described heretofore 1 cubic centimeter for each 30 cubic feet was sprayed into the room. At the end of the first hour seventeen insects were collected, and at the end of the second hour twelve. No toxic effects were noted. None of the insects recovered in twenty-four hours. The efficiency of this preparation is about 29 per cent under the conditions noted.

The fourth mixture was as follows:

Carbon tetrachloride	12.5
Methyl salicylate (synthetic)	25
Pyrethrum powdered (fresh)	60
Kerosene, q. s.	1,000

The first two ingredients were added to the filtrate after the pyrethrum had been extracted for two hours in the kerosene and filtered. One cubic centimeter of the mixture was used for each 30 cubic feet of air space. At the end of the first hour nineteen insects were picked up, and five additional ones were collected the second hour. No insect recovered in twenty-four hours. Efficiency rate about 24 per cent. Toxic effects slight.

Since we were convinced that most of the lethal effect of these sprays was due to pyrethrum, the task of finding a better solvent for the active principle or principles was undertaken.

Carbon disulphide and acetone were tried as solvents.

One hundred twenty cubic centimeters of carbon disulphide were added to 60 grams of pyrethrum powder and extraction continued for two hours. The mixture was shaken frequently during this time. The filtrate was added to sufficient kerosene to make the mixture up to 1,000 cubic centimeters. A preparation was made in the same manner using acetone instead of carbon disulphide. The filtrate from each of the above extractions amounted to about 40 cubic centimeters.

When these preparations were tried it was found that the carbon disulphide was toxic in concentrations of 1 cubic centimeter for each 85 cubic feet of air space, the mice showing much distress. One of them was unable to rise from the floor of the cage. The efficiency of this preparation was 95 per cent, ninety-

five of the hundred mosquitoes dying within one hour. The odor of this mixture was very objectionable.

The acetone spray proved to be toxic in concentration of 1 cubic centimeter for each 72 cubic feet of air space, the personnel suffering from nausea, headache, and dizziness. The mice showed every evidence of toxicity. The efficiency of the spray in this concentration was 100 per cent in the first hour.

A further objection to both the acetone and carbon disulphide mixtures is the danger of fires and explosions from matches, cigarettes, and sparking electrical installations. The toxicity alone would have condemned it since the use for which it was intended contemplated the presence of patients in the wards during the use of the spray.

It was found that the chloroform extract had none of the objections mentioned above. Concentrations up to 1 cubic centimeter for each 10 cubic feet of air space showed no toxic effects on small animals or man.

After 60 grams of powdered pyrethrum had been treated with 120 cubic centimeters of chloroform for two hours with frequent shaking, it was filtered through a Buchner funnel, the filtrate averaging about 50 cubic centimeters. The filtrate was made up to 1,000 cubic centimeters with kerosene.

Preliminary laboratory trials having shown that the efficiency of this preparation approached that of acetone and carbon disulphide extracts and that visible evidences of toxicity were absent in effective concentrations, it was decided that a trial would be made on a large scale. The ward selected was 15 feet high, 40 feet wide, and 164 feet 8 inches long, having a cubic content of 98,800 feet. The wall space measured 6,140 square feet. Of this area 1,115 square feet were represented by twenty-seven windows and four doors, all of which were simply spaces in the wall covered by screen wire or screen doors. No attempt was made to close any of them. All fans were stopped. Three thousand seven hundred fifty cubic centimeters of the chloroform-extract spray was liberated in the form of a fine mist and distributed evenly over the ward near the ceiling. This represented 1 cubic centimeter of the spray for each 26+ cubic feet of air space. Forty-three patients were present in the ward during the spraying and for twelve hours afterward.

Immediately after the spraying had been completed, a 20-mesh mosquito-netting cage, 20 by 12 by 12 inches, and containing one hundred *Aëdes* mosquitoes, was brought in and placed

on the floor near the center of the ward. At the end of thirty minutes ninety of the insects were on the floor of the cage. Three others were overcome during the night. No recoveries were noted in the subsequent twenty-four hours.

No complaints were registered by any of the patients in the ward, but on the other hand several stated that it was the first time they had not been annoyed by mosquitoes since they had been in the ward.

Several flies and cockroaches were found dead on the morning following the use of the spray. Later experience shows cockroaches and house ants as very susceptible to the action of this mixture.

To further prove the worth of the spray other wards of approximately the same size were treated in the same way. In the first of these, the concentration was 1 cubic centimeter to 21.4 cubic feet and in the second 1 cubic centimeter to 30.8 cubic feet. Efficiency was 93 per cent in the first and 87 per cent in the second.

One other ward was treated with straight chloroform in kerosene in the same quantity as that used to extract the pyrethrum. This showed an effectiveness of only 3 per cent. This number of insects might have died naturally during the night, although in all cases where these insects were used, food and water were kept constantly in the cages.

COMMENT

What seems to be a highly efficient and nontoxic spray is described. Experience with this and other mixtures with results obtained are related.

THE CONTROL OF ANOPHELES MINIMUS MOSQUITO LARVÆ IN THE PHILIPPINES BY STRANDING AND FLUSHING [1]

FIRST REPORT

By Paul F. Russell

Of the International Health Division of the Rockefeller Foundation

ONE PLATE AND ONE TEXT FIGURE

INTRODUCTION

It has long been known that in those parts of the Philippine Islands where there are distinct wet and dry seasons, the incidence of acute malaria is always less during the period of heavy rains—that is, from about July to November—than in the dry months from January to June. Lay testimony in the foothill districts is that the prevalence of "mosquitoes" is always reduced in the wet season.

It is well established that the principal vector of malaria in the Philippines is *Anopheles minimus*. The only other species under suspicion is *A. maculatus*, which Manalang (1) has recently found infected in nature. The larvæ of these two species of mosquitoes are most often found in the small streams of the foothills; and it is in this foothill zone, below 500 meters' altitude, that malaria is most prevalent and most severe.

Therefore, it has been assumed that the flushing of these foothill streams is a natural means of curtailing the incidence of malaria during the "typhoon season" of torrential rains, by its direct effect on the larvæ of *A. minimus*. There has been some proof of this assumption in the reports of the staff of malaria investigations who, after very heavy rains, have failed to find larvæ in routine examinations of such streams.

[1] These studies were made as a part of the program of malaria investigations, of which the author is chief, which are under the joint auspices of the Bureau of Science, Manila, and the International Health Division of the Rockefeller Foundation. Mr. D. Santiago, a field inspector of malaria investigations, assisted by making the collections reported in this experiment.

Mieldazis(2) noted this and in an experiment in 1929 attempted to make practical use of the phenomenon by discontinuing all control work in a selected area during the rainy season. This did not prove feasible as there were sharp outbreaks of malaria following cessation of control. It would appear that the natural flushing during the period of the experiment was irregular and sometimes widely spaced.

Bently(3) in Bombay and others have advocated flushing as a method of mosquito control. In fact, according to Hehir,(4) flushing has been an occasional public-health procedure since Empedocles flooded the lowlands surrounding Selinos, in ancient Greece, and thus made a pestilential city healthy. But in these cases the flushing has been more a flooding than a true flushing. In some cases, for example, it has made a lake of a marsh or of a stream. The present paper deals not with flooding in this sense, but rather with a scouring action on the larvæ below the dam and a stranding of larvæ above it.

PROCEDURE

In view of the apparent but unproved natural reduction of malaria in regions of the Philippine Islands by flushing action of heavy rainfall on the stream breeding places of *A. minimus*, the chief vector of malaria, it was determined to make some quantitative tests of the inhibitory effect of flushing on *Anopheles* larvæ in a stream which lent unusual opportunity for such a study.

FIG. 1. Branch of Mabacan River, near Calauan, Laguna Province, Luzon, showing location of dams and stations.

Through the generous coöperation of the Calauan Sugar Hacienda, Laguna Province, a small stream in Mabacan was put at our disposal (fig. 1). This branch of Mabacan River is a shallow, tortuous, clear, flowing stream, some parts with grassy banks, other sections fairly well shaded by overhanging bamboos and jungle growth. It is what is called in the Philippines a typical *A. minimus* breeding place, and has shown very large

numbers of larvæ. From its source, which is the junction of two smaller streams, to Mabacan River it is about 400 meters long. It has a normal depth varying from 15 to 50 centimeters. In width it varies from 1 to 2 meters, approximately. Almost at the mid-point between its source and outlet there is a cement dam which when closed permits the backing up of water to a level 115 centimeters above that of the stream when the dam is open. Closing is accomplished by blocking a round hole 50 centimeters in diameter (Plate 1).

In order first to determine the normal conditions of this stream, weekly collections were made from April 7 to May 19 below the dam and from the latter date until June 2 both above and below the dam. Each collection was made by dipping 80 times along the banks for larvæ. At all times *A. minimus* predominated by more than 90 per cent. Occasional larvæ of the following species were taken: *Anopheles filipinæ, A. vagus, A. barbirostris, A. maculatus,* and *A. fuliginosus.* The total catch of larvæ is shown in Table 1.

On June 8 the dam was closed at 5.52 a. m., had filled to its top, 115 centimeters from the bottom, at 8.56, and was opened at 9.10 a. m. Above the dam the depth of the stream had gradually changed from the normal of 15 to 50 centimeters to one varying from 115 centimeters near the dam to about 50 centimeters at the source. Below the dam the depth had gradually decreased to almost nil at the dam and not over 10 centimeters at the outlet where the influence of Mabacan River prevented any lower depth.

Upon opening the dam the water rushed out with considerable force, requiring about twenty-five minutes to resume its usual levels.

On June 9 the same dipping procedure, which had in previous weeks revealed some hundreds of larvæ, now resulted in a catch of 98 larvæ above and 41 below the dam—a marked reduction.

The following week larvæ were again present in their usual abundance, as recorded in the table.

On June 22 almost the same procedure was followed as on the 8th. An additional 30 centimeters' height of water behind the dam was secured by adding a board to the top. The dam was closed at 7.50 a. m., had filled to 135 centimeters' height by 2.00 p. m. and was opened at 2.27 p. m. It required about thirty minutes to empty.

TABLE 1.—*Anopheles larvæ dipped from branch of Mabacan River during an experiment with damming and flushing.*

Date.	Number of larvæ.		Remarks.
	Above dam.	Below dam.	
April 7	--------	394	Eighty dips.
April 11	--------	--------	Water raised 30 cm by casual obstruction at dam, suddenly released.
April 14	--------	192	Eighty dips.
April 21	--------	606	Do.
May 2	--------	--------	Water raised 60 cm by casual obstruction at dam, suddenly released.
May 5	--------	54	Eighty dips.
May 12	--------	132	Do.
May 19	--------	313	Do.
May 26	695	935	Do.
June 2	552	828	Do.
June 8	--------	--------	Dam purposely closed. Water level raised 115 cm, then released with moderate speed.
June 9	98	41	Eighty dips.
June 16	461	645	Do.
June 22	--------	--------	Dam purposely closed. Water level raised 135 cm, then released with moderate speed.
June 23	53	52	Ten stations, 80 dips.
July 6	--------	--------	Dam purposely closed. Water level raised 115 cm, then released with moderate speed. This procedure then repeated.
July 7	16	20	
July 14	222	862	
July 20	--------	--------	Dam purposely closed. Water level raised 115 cm, then released with moderate speed. This procedure then repeated.
July 21	13	23	
July 26	236	554	
July 27	--------	--------	Dam purposely closed. Water level raised 115 cm, then released with moderate speed. This procedure then repeated.
July 28	6	27	
			During the entire period of this experiment there were no heavy rains, the onset of the usual wet season having been delayed until August. Small larvæ included in the counting.

On June 23, as on June 9, the catch of larvæ was much smaller than usual (see Table 1).

On July 6, the procedure followed on June 8 was again employed, but this time it was repeated as soon as the water had emptied. In other words, there was a double flushing, the whole operation requiring about eight hours.

On July 7, the next day, relatively few larvæ were found. These larvæ and all subsequent catches in the experiment were not retained but were returned to the stream. As noted in the table, beginning on June 23 there were established ten definite dipping stations above and ten below the dam. These were

spaced at regular intervals, and all dipping was done at these places, identified by special markers.

By July 14 conditions were normal again. Another double flushing on July 20 resulted again in a strongly marked reduction in larvæ both above and below the dam.

On July 26 catches were normal, on July 27 a double flushing was done, and on July 28 the catches were almost nil.

During all of this period, from April 7 to July 28, there were no heavy rainfalls, the normally rainy July weather being absent. On August 7 the first typhoon signals of the season were displayed and two weeks of torrential rains introduced tardily the 1931 rainy season. This preliminary experiment was therefore brought to a close, although the stream remains under observation for further reports. (It may be noted that on August 18 the stream when dipped from source to outlet did not reveal a single larva. This was after very heavy rains.)

It is of interest that the effects of the dam in this experiment were as great above it as below. Below, the larvæ were destroyed or removed by the flushing action. Many must have been drowned by the turbulence of the waters released from the dam. It is known that wave action will, unless too gentle, destroy larvæ. For example, refer to Kibbey(5) who reported the control of breeding by using a power launch to patrol the shores of a lake. The boat created waves that splashed ashore and killed all larvæ. Practically 100 per cent control was obtained without the use of larvicides.

Above the dam the effect was probably one of stranding in the grasses and other vegetation, for the tendency of the larvæ was to stay at the edges as the water rose to higher levels. The fairly rapid fall must have left many of them out of water. Some probably were caught in the unusual current and perished below the dam. Observations on the effect of this procedure on malaria incidence will be reported later.

Much more study is needed but these first observations are convincing as to the potential usefulness of this simple and inexpensive method of destroying *A. minimus* larvæ, a procedure which imitates to some extent a natural malaria deterrent in the Philippine Islands.

DISCUSSION

Malaria in the Philippines can be largely obviated by attacking the *Anopheles minimus* mosquito. Whether *A. ludlowi* in the southernmost islands of the Archipelago will carry malaria

naturally, remains to be determined. The so-called *A. ludlowi* of Luzon is not a vector in nature.

There is no alternative method to that of larva control of *A. minimus* in fighting malaria in these Islands at present. The problem is simplified by the fact that this Philippine vector, as well as the recently convicted *A. maculatus*, breeds almost exclusively in the small streams of the foothills. Mountains and marshes, lakes and rice fields, stagnant waters generally, may all safely be ignored in the attempt to control malaria, according to present knowledge. The irrigation ditches of cane fields are sometimes attractive to *A. minimus* but not often.

It has been well demonstrated by Tiedeman(6) and Mieldazis(2) and by the United States Army Medical Corps at Fort Stotsenburg(7, 8) that the use of Paris green, distributed in the usual way, offers a method par excellence for the control of *A. minimus* breeding. There can be no doubt about this whatever in the light of the results obtained.

However, the situation is seriously complicated by cost of supervision and lack of funds. This is growing worse, with a small budget (75,000 pesos) about to become smaller by reason of the local effects of the present world-wide financial depression.

For these reasons the staff of malaria investigations is trying to find ways and means of reducing the cost and of minimizing the labor factor of malaria control.

The results of this preliminary experiment, in flushing and stranding *A. minimus* larvæ out of a stream, are, therefore, presented in the hope that in some places it may be possible by this means alone so to reduce the incidence of the *A. minimus* mosquito that it will not be at or above that critical number necessary to make it an effective vector of malaria. It is known from the studies of Ross(9) that it is not essential to destroy every last malaria-carrying mosquito to control malaria. Complete eradication, although occasionally feasible, is usually too costly a procedure.

Not every stream by any means will lend itself to this treatment, but many should. It is of special interest that the dam may be located near the mid-point of the length of the stream. This permits more rapid operation and obviates flooding a large area.

Further experiments are in progress not only in this type of control but also in such matters as the automatic distribution of Paris green and the preparation of a cheaper larvicide; all to the end that the incidence of *A. minimus* mosquitoes may be

reduced. Quinine and plasmochin have their place in the attack on malaria in the Philippines, but there would seem to be no real hope of success unless the chief emphasis is along the lines of mosquito control as first advised by Ross(10) many years ago.

SUMMARY

An experiment is reported in which an attempt was made to control *A. minimus* mosquito breeding in a small stream by periodically closing and opening a dam situated about halfway along the length of the stream. Quantitative observations show that this simple procedure done twice on one day a week brought about a marked reduction in larvæ both above and below the dam, probably by stranding above and by flushing below. It is suggested on the basis of this first experiment that such a simple and inexpensive method may be useful in controlling malaria in some areas in the Philippines.

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ILLUSTRATIONS

PLATE 1

FIG. 1. A dam on a small branch of Mabacan River, near Calauan, Laguna Province, Luzon; looking upstream.
2. Branch of Mabacan River, looking downstream; grassy unshaded banks.
3. Branch of Mabacan River, looking downstream into area of well-shaded banks.
4. Branch of Mabacan River, looking upstream.

TEXT FIGURE

FIG. 1. Map of a branch of Mabacan River, near Calauan, Laguna Province, Luzon, showing location of dams and stations.

1

2

3

4

PLATE 1.

BLOOD GROUPS IN PHILIPPINE MONKEYS

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INTRODUCTION

References in the literature concerning blood groups in monkeys are few. Troisier[2] reported that the blood corpuscles of the chimpanzee are agglutinated by human sera of the anti-A and anti-AB group and that the serum of this animal agglutinates human corpuscles of the B and AB type. Therefore, the blood of the chimpanzee has the characteristics of the human blood group A.

Thompson and Tage[3] published the results of their study concerning the blood grouping of the Pavian and the Macaccus. These animals apparently have the group specific receptors for human anti-B, but as regards the receptors for human anti-A the results were not conclusive. The sera of these animals, with two exceptions, contained human anti-A agglutinins.

Landsteiner and Miller[4] examined blood of anthropoid apes and concluded that "The isoagglutinogens of the anthropoids were found to be identical with those of human blood. These very same factors could not be demonstrated in the blood of the lower monkeys."

The results of investigations previous to ours show that there exists a relation between the blood of monkeys and the human types but that there are no blood groups among monkeys themselves.

The present communication gives the results of study concerning the relation between the blood of the Philippine monkey (*Cynomolgus philippinensis* Geoff.) and the human types.

[1] Lieutenant Colonel, Imperial Japanese Army.
[2] Ann. Inst. Pasteur 42 (1928) 363.
[3] Lancet 2 (1919) 675.
[4] Journ. Exp. Med. 42 (1925) 862.

MATERIAL AND TECHNIC EMPLOYED

HUMAN BLOOD

The samples of human blood were either taken outside and received as such or were taken at the laboratory from patients who reported for serologic examination.

The human sera were inactivated by exposure to 56° C. for thirty minutes on a water bath.

For the slide method defibrinated suspension of corpuscles was used, but in the quantitative test the red corpuscles were suspended in physiological salt solution in 5 per cent suspension. In performing the absorption test the suspension, or red corpuscles, was centrifuged for five minutes at a speed of 1,600 revolutions per minute.

MONKEY BLOOD

The samples of monkey blood were obtained by cardiopuncture and both the sera and the red corpuscles were treated in the same way as described under human blood.

TYPE SERA

The human-type sera used in our study were kindly supplied by the United States Army Medical Department Research Board. Standard human corpuscles of the groups A and B were determined each day with blood determined by standard type sera.

THE AGGLUTINATION TEST

The slide method.—For the grouping of human blood the slide method was used as follows: One loopful of each human-type serum A (anti-B) and B (anti-A) was placed separately on a slide and mixed with one loopful of the blood examined and then allowed to agglutinate at room temperature for about five minutes. During this time the blood sera mixtures were rocked back and forth.

Agglutination test in test tubes.—In order to find out the agglutinin titer of human and monkey serum the sera were used in dilution from 1:1 to 1:80, sometimes as high as 1:620. The dilutent used was physiologic salt solution and each test tube contained 0.5 cubic centimeter of diluted serum and 0.1 cubic centimeter of 5 per cent suspension of red blood corpuscles. These mixtures were allowed to agglutinate at room temperature (29° C. to 31° C.) and were shaken several times at intervals of from ten to fifteen minutes before the results were recorded.

The absorption method.—The sera to be absorbed were diluted from 1:5 to 1:10 with physiologic salt solution and to 3 cubic centimeters of these diluted sera, 0.1 cubic centimeter of red-cell sediment was added. This sediment was obtained by centrifuging for five minutes at the speed of 1,900 revolutions per minute, and allowed to absorb fifteen minutes at room temperature (29° C. to 31° C.). In the beginning of our work, we allowed the mixtures of sera and red cells to stand one hour at 37° C. in the incubator, but it was found that five minutes at room temperature followed by centrifuging was sufficient. The supernatant translucent diluted serum was pipetted off and used for quantitative agglutination test as already stated by the agglutination test in test tubes.

Recording.—Recording of the results obtained by the slide method was done within five minutes at room temperature (from 29° C. to 31° C.) because the agglutination by this method always occurred sooner and was clearer than by the test performed in test tubes. The results of agglutination were decided by the naked eye, but in case of doubt the microscope was used. Recording of the results obtained by the agglutination and saturation test in test tubes was done within two hours at room temperature (from 29° C. to 31° C.).

DETERMINATION OF BLOOD GROUPS IN HUMAN BLOOD SPECIMENS

In the course of examination of human blood and that of monkeys considerable information has been gathered with regard to the blood-group distribution among the population of Manila and vicinity. This may be of interest to mention.

From October 13 to December 19, 1930, 572 specimens were examined, and the results of the blood grouping by serologic reactions are presented in Table 1.

TABLE 1.—*Results of blood grouping by serologic reactions.*

Human blood group.	Number of specimens.	Percentage.
O	233	40.7
A	154	26.9
B	159	27.8
AB	26	4.5
Total	572	

The specimens belonging to group O were the most numerous. The specimens belonging to group A or B were equally represented, while those of group AB were the fewest.

The biochemic index of Manila's population was found to be 0.97. The specimens examined by us were taken from people who live in Manila and vicinity; therefore, a certain small portion of the specimens originated from other races than the Filipino, although the vast majority of these blood samples were taken from Filipinos. In as much as groups A and B are represented in equal proportions, the distribution of groups A and B among Filipinos is that of the intermediate type.

The biochemic index of Filipinos is Asio-African, because the European type shows an index higher than 2.0 and the Asio-African less than 1.3.

For the convenience of the reader the following distribution of blood groups in the three types, that is the European, the intermediate, and the Asio-African, is inserted.[5]

TABLE 2.—*Distribution of blood groups.*

Nationality.	A	B	Biochemical index.	Type.
English	46, 4	10, 2	4, 5	European.
French	45, 6	14, 2	3, 2	Do.
Italian	41, 8	14, 8	2; 8	Do.
German	48	17	2, 8	Do.
Austrian	48	18	2, 6	Do.
Bulgarian	46, 4	20, 2	2, 6	Do.
Serbian	45, 6	20, 2	2, 5	Do.
Greek	46, 8	20, 4	2, 5	Do.
Arab	37, 4	24	1, 5	Intermediate.
Turk	44, 6	25, 2	1, 8	Do.
Russian	32, 5	28, 1	1, 3	Do.
Jew	38	28, 2	1, 3	Do.
Malagasy	30, 7	28, 2	1, 09	Asio-African.
Negro	27, 6	34, 2	0, 8	Do.
Annamese	29, 6	35, 6	0, 8	Do.
Indian	27, 9	49	0, 5	Do.

EXPERIMENTS

In Table 3 are arranged the results of cross agglutination tests performed with the 572 human blood samples and monkey blood. The groups of these human blood specimens were determined and the sera as well as the red corpuscles were used for cross agglutination with the monkey serum and monkey red corpuscles, respectively. The slide method was applied.

[5] Lancet 2 (1919) 675.

It can be seen from this table that none of the human corpuscles belonging to the groups O and B were agglutinated by monkey serum. On the other hand, blood corpuscles belonging to groups A and AB were agglutinated by monkey serum. As to the agglutinability of monkey red cells by human sera, the results show that some human sera, irrespective of group, agglutinated monkey red cells.

TABLE 3.—*Showing the results of agglutination tests performed with human and monkey red cells and human and monkey sera.*

[Slide method.]

Date of test.	Human blood specimens arranged by groups.				Numbers of human blood specimens agglutinated by monkey serum arranged by groups.				Numbers of human sera which agglutinated monkey red cells.			
	Group AB.	Group A.	Group B.	Group O.	Group AB.	Group A.	Group B.	Group O.	Anti-O.	Anti-B.	Anti-A.	Anti-AB.
X-13	0	9	4	6	0	9	0	0	-----	-----	-----	-----
X-14	1	2	4	17	1	2	0	0	0	0	1	5
X-15	0	5	1	8	-----	4	0	0	-----	0	0	0
X-17	1	4	1	6	-----	4	0	0	0	0	0	0
X-20	2	6	2	9	-----	5	0	0	1	3	2	3
X-22	4	3	3	7	4	2	0	0	2	1	2	3
X-24	2	6	4	6	-----	2	0	0	1	2	3	2
X-27	2	10	8	3	-----	8	0	0	0	2	4	0
X-29	1	5	2	11	1	5	0	0	-----	1	2	4
X-31	1	1	6	6	1	1	0	0	0	1	3	6
XI-3	0	3	6	4	-----	1	0	0	-----	1	0	0
XI-5	0	4	8	8	-----	4	0	0	-----	1	3	6
XI-7	0	4	10	2	-----	4	0	0	-----	3	1	2
XI-10	0	9	4	5	-----	7	0	0	-----	4	0	2
XI-12	3	8	16	21	-----	5	0	0	1	0	4	10
XI-14	1	7	5	11	1	7	0	0	0	0	2	5
XI-17	0	5	2	10	-----	3	0	0	-----	1	1	5
XI-19	0	6	10	6	-----	4	0	0	-----	2	5	5
XI-21	0	5	7	5	-----	5	0	0	-----	3	5	2
XI-24	1	5	5	12	-----	3	0	0	1	0	3	7
XI-26	0	5	4	9	-----	3	0	0	-----	3	2	7
XI-28	0	2	3	3	-----	1	0	0	-----	1	1	2
XII-2	0	7	7	2	-----	7	0	0	-----	6	5	2
XII-3	1	3	4	10	1	3	0	0	1	2	2	7
XII-5	3	9	10	9	1	7	0	0	1	6	8	4
XII-8	1	6	12	17	1	4	0	0	0	0	5	7
XII-12	0	6	4	5	-----	3	0	0	-----	1	2	2
XII-16	1	7	4	14	-----	5	0	0	1	4	3	7
XII-19	1	2	3	1	-----	2	0	0	0	1	3	0
Total	26	154	159	233	11	120	0	0	9	49	72	105

The procedure of tests performed daily is evident from Table 4.

In Tables 5 and 6 the results of the agglutination test are given, which show quantitatively the agglutination by human blood serum of group A, of monkey red corpuscles and vice versa. The agglutination test included control groups B and O. This experiment was undertaken to confirm the findings obtained by the slide method as given in Table 3 which showed that none of the corpuscles of the two groups O and B were agglutinated by monkey serum and only those corpuscles that contained the element A were agglutinated. In Table 5 it is shown that distinct agglutination of group A red cells was obtained up to the dilution of 1 to 160 and in some instances as high as 640. The absence in monkey serum of agglutinins for human red cells of the groups O and B is evident from the results obtained with the controls.

In Tables 7 and 8 are recorded human sera that were tested with regard to agglutinins toward monkey red cells. The human sera belonged to various groups as indicated in the tables. The results show that some human sera agglutinate monkey red cells while others do not. The agglutinins in human sera toward

TABLE 4.—*Showing an example of daily examinations concerning types of human and monkey blood (October 22, 1930).*

Blood No.	Human test sera.		Human standard corpuscles.		Results of grouping.	Monkey sera.			Monkey corpuscles.	
	A (anti-B)	B (anti-A)	A	B		A-8	J-18	Z-1	A-8	Z-1
1	+	+	—	—	AB	+	+	+	—	—
2	—	—	+	+	O	—	—	—	—	—
3			+	—	B				—	+
4	—	—	+	+	O	—	—	—	—	—
5	—	—	+	+	O	—	—	—	—	+
6	—	—	+	+	O	—	—	—	—	—
7	—	+	—	+	A	+	+	+	+	+
8	+	—	+	—	B	—	—	—	—	—
9	+	—	+	—	B	—	—	—	—	+
10	+	+	—	—	AB	+	+	+	+	+
11										
12	—	—	+	+	O	—	—	—	+	+
13	—	—	+	+	O	—	—	—	—	—
14	—	+	—	+	A	+	+	+	—	—
15	—	—	+	+	O	—	—	—	—	—
16	+	+	—	—	AB	+	+	+	+	+
17	+	+	—	—	AB	+	+	+	—	—
18			—	+	A				—	—

monkey red cells have no relation to the blood groups to which the sera belong.

Thus far it is clear that the monkey serum appears to have a definite relation to the human groups in as much as it behaves towards human corpuscles just the same as human serum of group B does, but monkey corpuscles behave irregularly in their agglutinability by human sera. This finding casts a shade of doubt on the identity of the agglutinins contained in the monkey serum with the agglutinin of human sera of group B.

TABLE 5.—*Showing the results of agglutination test performed with monkey serum and several samples of human red cells group A. As controls, human red cells group B and group O were used.*

[Test-tube method.]

Human red cells.	Monkey serum.					
	1/1	1/20	1/40	1/80	1/160	1/320
Group A	+++	+++	+++	+++	+	—
Do	+++	+++	+++	+++	++	+
Do	+++	+++	+++	++	++	+
Do	+++	+++	+++	+++	+	+
Do	+++	+++	+++	+++	++	++
Group B	—	—	—	—	—	—
Group O	—	—	—	—	—	—
Do	—	—	—	—	—	—

TABLE 6.—*Showing the results of agglutination test performed with several monkey sera and human red corpuscles, group A.*

[Test-tube method.]

Monkey serum dilution.	Human red corpuscles group A.					
	1/20	1/40	1/80	1/160	1/320	1/640
f–2	+++	+++	++	++	+	—
K–26	+++	+++	++	++	—	—
M–No. 1	+++	+++	+++	+++	++	+
K–28	+++	+++	++	+	—	—
Z–1	+++	+++	++	+	—	—
T–16	+++	+++	++	+	—	—
f–1	+++	+++	++	++	—	—
Int No. 2	+++	+++	+++	+++	+++	
Le–No. 2	+++	+++	++	+	+	
W–18	+++	+++	++	++	+	
Sy–25	+++	+++	++	+	—	—
J–15	+++	++	+	—	—	—

In order to investigate further the relation of Philippine monkey blood to the known human blood groups, the identity of the monkey agglutinins with that of human group B was tested by means of absorption experiments.

In an experiment given in Table 9 human serum of group A was absorbed by human red cells of group B. Another portion of the same human serum was absorbed by monkey red cells. Thus treated, sera were then tested for agglutination

TABLE 7.—*Showing the results of agglutination tests of monkey red corpuscles by human sera belonging to various groups.*

Human serum No.—	Blood group.	Serum dilution.						
		1/1	1/5	1/10	1/20	1/40	1/80	1/160
7	A	+++	+++	++	±			
18	A	—	—	—	—			
8	A	+++		++	+	—	—	—
9	A	+++		+	—	—	—	—
14	A	+++		+++	+	—	—	—
15	A	+		—	—	—	—	—
9	A	—		—	—	—	—	—
3	B	+++	+++	++	±	—		
9	B	+	—	—	—			
17	B	—		—	—	—	—	
18	B	+++		+	+	—	—	
19	B	—		—	—	—	—	
18	B	—		—	—	—	—	—
22	B	+++		—	—	—	—	—
33	B	+++		—	—	—	—	—
45	B	+++		+	—	—	—	—
1	AB	—	—	—	—			
17	AB	—	—	—	—			
7	AB	+++	+++	+++	++	—	—	—
2	O	++	++	—	—			
13	O	—	—	—	—			
8	O	+++		++	+	—	—	
12	O	+++		+++	+++	++	++	
20	O	—		—	—	—	—	
22	O	+		—	—	—	—	
23	O	++		+	—	—	—	
6	O	++		—	—	—	—	
12	O	+++		+++	++	++	+	—
21	O	—		—	—	—	—	—
5	O	+++		++	—	—	—	—
8	O	+++		—	—	—	—	—
20	O	+++		—	—	—	—	—
26	O	+++		+++	+	—	—	—
39	O	+++		+++	+++	+	—	—
43	O	+++		—	—	—	—	—

with human red cells group B and with monkey red cells. The result was that the human red cells group B absorbed the agglutinins from human serum group A for human corpuscles group B, but not those for monkey corpuscles and vice versa. Further absorption experiments in various combinations performed with monkey serum and red cells, and with human sera and red cells belonging to various groups showed conclusively a distinct specificity of the agglutinins in Philippine monkey serum and of those encountered in human sera (Tables 9, 10, and 11).

TABLE 8.—*Showing the results of agglutination performed with ten samples of monkey red cells and ten samples of human blood sera belonging to various blood groups.*

Human serum.		Monkey red corpuscles.									
No.	Blood group.	Z–1	W–18	L–2	J–15	T–16	Int–2	R–4	f–2	W. R–1	Java–1
3	A	—	—	—	—	—	—	—	—	—	—
5	A	—	+	+	—	—	—	—	—	+++	—
12	A	—	—	—	—	—	—	—	—	—	—
1	B	—	—	—	—	—	—	—	—	+	—
10	B	+	+++	+++	+++	++	+++	+++	+	+++	+
2	O	—	—	—	—	—	—	—	—	—	—
4	O	+	++	+++	+	++	+	+	+	+++	+
7	O	+++	+++	+++	+++	+++	+++	+++	++	+++	+++
8	O	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++
9	O	—	—	—	—	—	—	—	—	—	—

SUMMARY

A series of investigations concerning the relation between human blood groups and the blood of Philippine monkeys showed that the serum of Philippine monkeys contains distinct agglutinins for the human blood group element A. It agglutinates, therefore, red corpuscles of the group A and group AB exclusively. It does not agglutinate human red corpuscles of the other groups. Monkey red cells, on the other hand, are agglutinated by a certain portion of human sera irrespective of the blood group to which they belong. Absorption experiments showed distinct specificity of the anti -A agglutinins in the monkey serum and a distinct specificity of the anti -A agglutinins in human serum. Likewise, the agglutinins contained in some

TABLE 9.—*Showing the results of agglutination test performed with human serum group A, which has been absorbed by human red cells group B, as compared with human serum of a group absorbed by monkey red cells.*

[Test-tube method.]

HUMAN SERUM GROUP A ABSORBED BY HUMAN RED CELLS GROUP B.

Red cells.	Before absorption.						After absorption.					
	1/10	1/20	1/40	1/80	1/160	1/320	1/10	1/20	1/40	1/80	1/160	1/320
Human group B	+++	+++	+++	++	++	—	—	—	—	—	—	—
Monkey	++	++	++	—	—	—	++	++	+	—	—	—
HUMAN SERUM GROUP A ABSORBED BY MONKEY RED CELLS.												
Human group B	+++	+++	+++	++	++	—	+++	+++	+++	++	++	—
Do	+++	+++	+++	++	+	—	+++	+++	+++	++	+	—
Do	+++	+++	+++	++	+	—	+++	+++	+++	++	++	—
Do	+++	+++	+++	++	+	—	+++	+++	+++	++	+	—
Do	+++	+++	+++	++	+	—	+++	+++	++	++		
Monkey	++	++	++	—	—	—	—	—	—	—	—	—
Do	+++	+++	++	+	—	—	—	—	—	—	—	—
Do	+++	+++	++	++	+	—	—	—	—	—	—	—
Do	+++	+++	++	+	—	—	—	—	—	—	—	—
Do	+++	+++	++	++	+	—	—	—	—	—	—	—

TABLE 10.—*Showing the results of agglutinations performed with human serum group B, which has been absorbed by human red cells group A, as compared with human serum group B absorbed by monkey red cells.*

[Test-tube method.]

HUMAN SERUM GROUP B ABSORBED BY HUMAN RED CELLS GROUP A.

Red cells.	Before absorption.						After absorption.					
	1/10	1/20	1/40	1/80	1/160	1/320	1/10	1/20	1/40	1/80	1/160	1/320
Human group A	+++	+++	+++	++	—		—	—	—	—		
Monkey							+++	++	+	—		
HUMAN SERUM GROUP B ABSORBED BY MONKEY RED CELLS.												
Human group A	+++	+++	+++	++	—		+++	+++	+++	+++		
Do	+++	++	+	—	—		+++	+++	++	+		
Do							+++	+++	++	+		
Monkey	++	+	—	—	—		—	—	—	—		
Do	+++	++	+	—	—		—	—	—	—		
Do	+++	++	+	—	—		—	—	—	—		

TABLE 11.—*Showing the results of agglutination test performed with human red cells groups A and B and monkey red cells. Human sera groups A and B and monkey sera absorbed by human red cells groups A and B and by monkey cells were used.*

Red cells used for—		Agglutination test.									
		Before absorption.					After absorption.				
Absorption.	Agglutination.	1/5	1/10	1/20	1/40	1/80	1/5	1/10	1/20	1/40	1/80
Human A	Human A	+++	+++	+++	++	+	—	—	—	—	—
Do	Human B	+++	+++	+++	++	+	+++	+++	+++	++	++
Do	Monkey	+++	+++	+++	++	—	+++	+++	+++	+++	—
Human B	Human A	+++	+++	+++	++	+	+++	+++	+++	+++	—
Do	Human B	+++	+++	+++	++	+	—	—	—	—	—
Do	Monkey	+++	+++	+++	+	—	+++	+++	+++	++	—
Monkey	Human A	+++	+++	+++	++	+	+++	+++	+++	++	+
Do	Human B	+++	+++	+++	++	+	+++	+++	+++	+++	+
Do	Monkey	+++	+++	++	—	—	—	—	—	—	—

TABLE 12.—*Showing the results of agglutination test performed with human red cells groups A and B and monkey red cells. Human serum group O absorbed by human red cells group A and by monkey red cells was used.*

Red cells used for—		Agglutination test.							
		Before absorption.				After absorption.			
Absorption.	Agglutination.	1/10	1/20	1/40	1/80	1/10	1/20	1/40	1/80
Human A	Human A	+++	+++	+++	+++	—	—	—	—
Do	Monkey	+++	+++	+++	+++	++	+++	++	++
Monkey	Human A	+++	+++	++	+	+++	++	++	+
Do	Human B	+++	++	++	++	+++	+++	+++	+++
Do	Monkey	+	—	—	—	—	—	—	—
Do	Human A	+++	++	+	—	+++	++	—	—
Do	Human B	+++	+++	++	+	+	+	—	—
Do	Monkey	++	++	+	—	—	—	—	—
Do	do	++	++	+	—	—	—	—	—

human sera were found to be specific towards monkey red cells and were different from group agglutinins in the human sera.

CONCLUSION

The anti-A agglutinins contained in the serum of Philippine monkeys are different from the anti-A agglutinins contained in human serum type B. However, for the determination of human blood groups, the serum of Philippine monkeys can be used in place of human serum type B.

EXPERIMENTAL INQUIRY INTO THE POSSIBILITY OF TRANSMISSION OF YAWS BY LEECHES

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The experimental evidence concerning indirect transmission of yaws has been gathered from the available literature and critically discussed by Yasuyama.[2]

Leeches are mentioned as possible vectors of yaws infection in the literature, on purely speculative grounds, but we failed to find any records of experiments or other convincing evidence to justify such a belief. They are widely distributed throughout tropical marsh lands and freely attack people who in their daily tasks visit these regions. In view of the fact that leeches were found by Boynton[3] to harbor the virus of rinderpest for a long time and that viable plague bacilli were found by Schöbl in the blood ingested by leeches from a plague patient,[4] an inquiry into the possibility of transmission of yaws by leeches appeared to us justified and within the scope of the investigations concerning yaws that have been conducted in our laboratory during the past seven years. Moreover, Robertson in Ceylon[5] demonstrated that leeches may become vectors of *Trypanosoma*-infection, and Sakravoy, Rosenbach, Blumer, and Mitchel[6] noted that malarial parasites remained alive for several days in the blood ingested by leeches from malaria patients.

EXPERIMENTS

Common Philippine leeches secured in a drug store in Manila were used in these experiments. Philippine monkeys inoculated with the Kadangan strain of yaws,[7] which developed typical yaws

[1] Lieutenant Commander Surgeon, Imperial Japanese Navy.
[2] Philip. Journ. Sci. 35 (1928) 333.
[3] Philip. Journ. Sci. § B 8 (1913) 509.
[4] Oral communication.
[5] Quart. Journ. Micr. Sci. No. 213, 54 (1909) 138.
[6] Cited by Bas and Johns, Journ. Exp. Med. 16 (1912) 568.
[7] Philip. Journ. Sci. 35 (1928) 209.

lesions containing treponemas at the moment of the experiment, were employed as donors. The leeches were allowed to ingest the lymph and blood oozing directly from the lesions. After feeding, each individual leech was placed in a separate Petri dish. At definite periods of time, after feeding, the entire blood content of each leech was taken up by an individual sterilized hypodermic syringe, examined microscopically, and inoculated into normal monkeys by intradermal inoculation.

EXPERIMENTAL FINDINGS

The results of the microscopic examination of the content of the leeches after feeding on experimental yaws lesions for treponemas are somewhat irregular. Sixteen trials were made with sixteen leeches, several yaws animals being used as donors of yaws material. Of the sixteen trials, treponemas were not found in five instances. In three instances only one examination was made. In eleven trials treponemas were found in every instance, very often repeatedly.

Since treponemas were found in the leeches after feeding on yaws lesions in a fair percentage of experiments we proceeded to test their viability in the body of the leeches. Six monkeys with experimental yaws lesions containing demonstrable treponemas at the time of the experiment served as donors, and six normal monkeys were inoculated with the content of the leeches fed on yaws lesions. From Table 2 it can be seen that in not a single instance did the inoculation produce a lesion.

DISCUSSION

The search for treponemas in the yaws material after ingestion by leeches, with the help of the dark-field microscope, revealed them in a large percentage of instances when repeated examinations were made. In some trials treponemas were not found when microscopic examinations were made at short intervals after feeding, while they were encountered later when the same material was examined after feeding. This finding may seem to suggest that a certain degree of multiplication takes place in the body of the leech; in other instances, however, reverse findings were made. It merely shows that the treponemas present in the ingested blood were few and unevenly distributed.

Even though present in the body of the leeches the treponemas were not viable as demonstrated by inoculation to normal

TABLE 1.—*Showing the results of microscopic examination of leeches fed upon yaws lesion.*

[+, positive finding; —, negative finding.]

Treponema in the lesion of donor.	Time between feeding and microscopic examination.	Result of darkfield microscopic examination.	*Treponema* in the lesion of donor.	Time between feeding and microscopic examination.	Result of darkfield microscopic examination.	*Treponema* in the lesion of donor.	Time between feeding and microscopic examination.	Result of darkfield microscopic examination.
	Hours.							
+	[a]	—	+	[a]	—	+	24	—
+	0.5	—	+	[a]	—	+	25	—
+	1.25	+	+	1	—	+	11	+
+	25.0	—	+	2	—	+	12	+
+	[a]	—	+	3	+	+	12	+
+	0.5	—	+	23	—	+	13	+
+	2	+	+	23	—	+	23	—
+	[a]	—	+	24	—	+	24	—
+	[a]	—	+	[a]	—	+	12	+
+	0.5	—	+	1.75	—	+	13	+
+	1	—	+	3.5	—	+	23	—
+	1.5	+	+	5	+	+	24	—
+	2	+	+	10	+	+	[a]	+
+	2.5	+	+	12	+	+	13	—
+	3	+	+	23	+	+	14	—
+	23	—	+	24	—	+	[a]	+
+	25	—	+	23	—	+	13	—
+	28	—	+	24	—	+	14	—

[a] Examined immediately.

TABLE 2.—*Showing the results of animal experiments on viability of Treponema pertenue in leeches.*

[+, positive finding; —, negative finding and negative take.]

Treponema in the lesion of donor.	Time between feeding and inoculation to monkeys.	Recipient monkey No.	Result.	
			Microscopic.	Take.
+	Immediately	1–a	—	—
+	Thirty minutes	2–a	—	—
+	One hour	3–a	—	—
+	Two hours	1–b	—	—
+	Three hours	2–b	—	—
+	Immediately	3–b	—	—

highly susceptible animals. Experiments performed in this laboratory by Yasuyama [8] concerning the viability of *Treponema pertenue* and the presence of treponemas in yaws material exposed to unfavorable conditions indicate that a lesion will not

[8] Philip. Journ. Sci. 35 (1928) 333.

necessarily result from inoculation of such material to an experimental animal that shows high susceptibility to yaws when fresh material is inoculated. This observation, previously made, explains the seeming discrepancy between the microscopic findings of treponemas in the leeches as late as twenty-three hours after feeding and inoculations that gave constantly negative results with respect to formation of lesions. The objection that the monkeys, recipients of the yaws material from the leeches, were immune to yaws does not hold, because the same monkeys inoculated subsequently with yaws developed typical yaws.

The results of experiments concerning the viability of *Treponema pertenue* in the body of common leeches in the Philippines show that the possibility of transmission of yaws by these blood-sucking animals is very remote indeed.

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PERMANGANATE-HIDE-POWDER GRAPH FOR TANNIN ANALYSIS OF WOOD BARKS

RESULTS BY THE MODIFIED HIDE-POWDER METHOD, OBTAINED FROM THE PERMANGANATE DETERMINATION

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ONE PLATE

A number of methods have been suggested for the determination of tannins in woods and barks. In general, the hide-powder method is considered the most accurate. This method is somewhat tedious to carry out and is not favored by some chemists.

Recently we had occasion to determine the tannin content of some Philippine wood barks. We used both the permanganate method and a modification of the official hide-powder method. Our experiments indicated that for certain Philippine wood barks there is a direct relation between the results obtained by these two methods. That is, the results obtained by the permanganate determination may be referred to a graph which gives the corresponding results in terms of the modified hide-powder method. Perhaps this permanganate-hide-powder graph may be of general application for the determination of tannins in wood barks.

EXPERIMENTAL PROCEDURE

In this investigation, the following tropical tree barks were analyzed by both the modified hide-powder and permanganate methods.

1. Bagtikan, *Parashorea malaanonan* (Blco.) Merr.
2. Liusin, *Parinarium corymbosum* (Blm.) Miq.
3. Santol, *Sandoricum koetjape* (Burm. f.) Merr.
4. Bitaog, *Calophyllum inophyllum* Linn.
5. Sakat, *Terminalia nitens* Presl.
6. Kalumpit, *Terminalia edulis* Blco.
7. Talutó, *Pterocymbium tinctorium* (Blco.) Merr.
8. Kariskis, *Albizzia lebbekoides* (DC.) Benth.
9. Kamachile, *Pithecolobium dulce* (Roxb.) Benth.

A description of the trees from which these barks were obtained is given by Schneider.[1] These trees were growing on Mount Makiling near Los Baños in Laguna Province. They were full-grown, mature trees and were selected by Mr. H. M. Curran, of the Bureau of Forestry, who identified the species and shipped the bark samples to our laboratory in Manila.

Samples of these barks were prepared for analysis by first drying them in an oven at 60° C. for about twenty hours. The barks were then filed with a rasp and the filings sieved through a 20-mesh screen. The bark powder which passed through this sieve was used for the analysis.

Moisture determinations were made on all these bark powders, and the results of analysis were calculated on a moisture-free basis.

In preparing our tannin extracts of the wood barks for both the permanganate and hide-powder methods we used the official method employed for making tannin extracts of tea leaves.[2]

In analyzing barks by our modified hide-powder method we followed, in general, the procedures given by the Association of Official Agricultural Chemists [3] for determining the soluble solids and nontannins. We used a quantity of bark estimated by previous experiments to yield approximately 4 grams of tannin per liter of extract. The powdered bark contained in a round-bottomed flask was extracted, with occasional shaking, on a steam bath with 400 cubic centimeters of water for thirty minutes. The mixture was then filtered into a half-liter volumetric flask and the residue washed thoroughly with hot water, the washings draining into the extract contained in the flask below. The filtrate was then cooled to room temperature and diluted to a volume of half a liter giving the standard tannin extract.

To ascertain if the residue contained any more tannin the residue was boiled with water, with occasional shaking, for another half hour and filtered. The filtrate from the residue of each bark analyzed gave negative tests for tannins, showing that all the tanning material was obtained in the first extraction.

[1] Philip. Bur. Forestry Bull. 14 (1916).

[2] Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists (1925) 341.

[3] Op. cit. 73.

The apparatus recommended for the official hide-powder method may give a more complete extraction than the procedure we used. However, with a more complete extraction there is a tendency to remove not only all the tannins but also some of the nontannin material which, for the gravimetric hide-powder method, might tend to interfere with the determination of the true tannin content of the bark.

An aliquot portion of the standard tannin extract prepared according to our procedure was used for the determination of soluble solids according to the official methods except that the extract was maintained at room temperature instead of 20° C. because it is rather inconvenient to maintain that temperature in the Tropics. However, since tropical temperature is usually very uniform throughout the day, any differences in results due to temperature changes would be well within the experimental error.

For the determination of nontannins we again followed, in general, the procedures given by the official methods, except that we kept our prepared chrome-hide powder in a refrigerator to inhibit bacterial growth which tends to decompose hide powder in the Tropics.

In carrying out these procedures we did not correct for moisture retained by the hide powder because experiments in our laboratory showed that the moisture retained by the hide powder was just about equivalent to the moisture in the leather precipitate.

The tannin content of the barks is, of course, the difference between the percentage of soluble solids and nontannins.

In determining tannins in wood barks by the Löwenthal-Procter permanganate method, we followed the official procedure of the Association of Official Agricultural Chemists for determining the tannin content of tea leaves.[4]

The various kinds of tannins are supposed to have different reducing powers. The actual reduction equivalents of most of these tannins have not as yet been worked out accurately. It is rather difficult to prepare the tannins in pure condition since they often occur as mixtures that are not easy to separate.

[4] Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists (1925) 340. Leach, A. E., and A. L. Winton, Food Inspection and Analysis (1920) 383. Procter, H. E., Journ. Soc. Chem. Ind. 3 (1884) 82.

Our results by the permanganate method were expressed in percentage of gallotannic acid. We used the factor 0.0042 gram tannin (gallotannic acid) as equivalent to 1 cubic centimeter of 0.1 normal oxalic acid because that is one reduction equivalent that seems to have been worked out fairly accurately. In case the reduction equivalent of a particular tannin should be worked out and found to be different from that of gallotannic acid and that tannin is known to be present in a certain bark by actual tests, then the results expressed as percentage of gallotannic acid may be converted into the percentage of that particular tannin by multiplying by the proper factor. By expressing the results as gallotannic acid we have a uniform standard of comparison. This would seem to be desirable, especially since little is known of the actual reducing powers of the individual tannins.

The permanganate method for the determination of tannins is very rapid and convenient. This method, however, gives results which are higher than the actual percentage of tannins contained in the wood barks. The reason for this is that not only tannins but other water extractives reduce the permanganate. Most of the water extractives, especially the coloring matter, are carried down with tannin in the gelatin precipitation. The percentage of tannin obtained by the permanganate method is therefore likely to be abnormally high.

Recently we had occasion to analyze some Philippine wood barks for tannins. We used both the permanganate method and our modified hide-powder method. The results are recorded in Table 1.

TABLE 1.—*Tannin analyses of Philippine wood barks by the permanganate and modified hide-powder methods.*

Sample No.	Name of tree bark.	Tannin content.	
		Determined by permanganate method.	Determined by hide-powder method.
		Per cent.	*Per cent.*
1	Bagtikan	5.31	2.64
2	Liusin	10.77	6.82
3	Santol	17.52	11.80
4	Bitaog	26.86	19.12
5	Sakat	36.76	27.38
6	Kalumpit	55.51	42.00

The figures given in Table 1 are the averages of closely agreeing duplicate determinations. As shown by the data the permanganate method gave much higher results than the hide-powder method. The laboratory data for one of these barks (kalumpit) was as follows:

PERMANGANATE METHOD

1 gram of bark gives 100 cc standard tannin extract.
1 gram of bark gives a volume of 250 cc for gelatin precipitation (100 cc tannin extract + 50 cc gelatin salt solution + 100 cc acid sodium chloride solution).
44.9 cc $KMnO_4$ equivalent to 10 cc tannin extract.
18 cc $KMnO_4$ equivalent to 25 cc of filtrate from gelatin precipitate.
$44.9 - 18 = 26.9$.
$26.9 \times 10 = 269$ cc $KMnO_4$ required to oxidize the tannins and other extractives precipitated from 1 gram of bark.
269×0.4209 (oxalic acid factor) $= 113.2$ cc 0.1 *N* oxalic acid.
Gallotanic acid factor used was 0.0042.
$113.2 \times 0.0042 = 0.4755$ gram tannin in 1 gram bark.
$0.4755 \times 100 = 47.55$ grams tannin in 100 grams bark.
100 grams bark contains 14.34 grams moisture.
47.55 grams tannin in 85.66 grams dry bark.
$\frac{47.55}{85.66} \times 100 = 55.51$ per cent tannin in dry bark by permanganate method.

HIDE-POWDER METHOD

1 gram of bark gives 100 cc standard tannin extract.
For soluble solids 100 cc tannin extract gave 0.4270 grams of residue.
For nontannins 100 cc of hide-powder filtrate gave 0.0672 grams of residue.
$0.4270 - 0.0672 = 0.3598$ gram tannin in 1 gram of bark.
$0.3598 \times 100 = 35.98$ grams tannin in 100 grams bark.
100 grams bark contains 14.34 grams moisture.
$\frac{35.98}{85.66} \times 100 = 42$ per cent tannin in dry bark by hide-powder method.

The six samples of wood barks (Table 1) gave aqueous extracts which, though colored, seemed to be unusually free of the kind of coloring matter and other substances which tend to interfere with the hide-powder determination. For this reason these barks were analyzed easily by our modified hide-powder method, and we believe that this method gave the correct tannin content of these barks.

The tannin content of these barks ranged from a low to a high percentage. When these barks were analyzed by the permanganate and modified hide-powder methods and the results plotted in the curve, the resulting graph was found to be almost

a straight line as shown in Plate 1. This would indicate that the reducing power of the tannins in these barks was approximately of the same degree. Extracts from two of these barks of the *Terminalia* species (sakat and kalumpit) gave very positive tests for gallotannins. It would seem that the tannins in the other four barks apparently had about the same reducing power as gallotannic acid.

From a consideration of these facts it would seem that there is a direct relation between the results obtained by the permanganate and modified hide-powder methods when there are no substances present to interfere with the accuracy of the hide-powder method and the tannins present in the barks have the reduction equivalent of gallotannic acid.

If it is true that in the case of gallotannins there is a direct relation between the results obtained by the permanganate and modified hide-powder methods, then to get the correct tannin content of a tree bark it would seem to be only necessary to analyze the bark by the rapid permanganate method and refer the result to our permanganate-hide-powder graph (Plate 1). This gives the corresponding figure representing the tannin content of the bark by the modified hide-powder method for gallotannic acid and other tannins of equal reducing power. For tannins having a different reducing power the percentage of gallotannic acid (obtained from the curve) should be multiplied by the proper reduction equivalent factor if that is known.

In Table 2 are given the results of analyses of three other barks by the permanganate and modified hide-powder methods.

TABLE 2.—*Tannin analyses of Philippine wood barks by the permanganate and modified hide-powder methods.*

Sample No.	Name of tree bark.	Tannin content.		
		Determined by permanganate method.	Determined by hide-powder method.	Hide-powder method corresponding to permanganate results from graph. [a]
		Per cent.	*Per cent.*	*Per cent.*
7	Taluto	15.41	15.41	10.20
8	Kariskis	30.33	23.93	21.90
9	Kamachile	40.31	33.22	30.10

[a] These figures, representing results by the hide-powder method, were obtained from the permanganate determinations by applying the permanganate–hide-powder graph (Plate 1).

With the taluto bark (sample 7, Table 2) both the permanganate and modified hide-powder methods gave the same percentage of tannin. In using the permanganate method, the gelatin precipitate carries down all the coloring matter and possibly other water extractives which, of course, gives a high result.

In using the hide-powder method with this particular wood bark the hide-powder precipitate also appeared to carry down coloring matter and other water extractives, because the filtrate was very much lighter in color than the original extract. Quite likely the hide-powder precipitate carried down the bulk of the coloring matter and water extractives. Naturally, in this case the hide-powder method gives a high result. As a matter of fact, as shown by the data (Table 2), both the permanganate and the hide-powder method gave the same percentage of tannin for this sample of taluto bark. Probably the hide-powder precipitate carried down about the same amount of coloring matter and water extractives as the gelatin precipitate in the permanganate method.

In the case of the kariskis and kamachile barks (samples 8 and 9, Table 2) the hide-powder precipitate carried down a small quantity of coloring matter and water extractives. This made the results for the hide-powder method somewhat high.

From a consideration of our results it would seem that in analyzing barks like our first six samples (Table 1) the hide-powder method gives very accurate results because there are no interfering factors. Where there are interfering factors, as in the case of our barks 7, 8, and 9 (Table 2), the hide-powder method does not give accurate results.

Fortunately, the first six wood barks recorded in Table 1 seemed to serve as ideal samples for the hide-powder method, and we were able to construct a graph showing the direct relation between the results obtained by the hide-powder and permanganate methods. Having once constructed this graph accurately it is not necessary to use the tedious hide-powder method for determining tannins. We have only to employ the rapid permanganate method and refer the results to our graph which gives the corresponding figure representing the accurate tannin content by the modified hide-powder method.

An interesting point in connection with this permanganate-hide-powder graph is that the tannin percentages obtained by it, representing results by the modified hide-powder method,

are always of a minimum value. For instance in the case of the kariskis bark (sample 8, Table 2) the tannin content by the permanganate method gave 30.33 per cent. As indicated by the graph this corresponds to 21.90 per cent tannin by the modified hide-powder method. The actual determination of tannin by the modified hide-powder method gave 23.93 per cent, which is somewhat higher than the result indicated by the graph. In this case the hide-powder method gave a result somewhat abnormally high due to interfering factors. However, by using the rapid permanganate method and referring the result to the permanganate-hide-powder graph the correct tannin content, representing the result by the modified hide-powder method, is obtained.

Similar results were found with the taluto and kamachile barks (Table 2). In each case the hide-powder method gave abnormally high results, but the correct tannin content may be obtained by use of the permanganate method and our permanganate-hide-powder graph.

Obviously there are many advantages in using the rapid permanganate method for determining the tannin content of wood barks. This method is easy to carry out and very rapid. Again the same quantity of sample (5 grams) is used for the analysis of different barks irrespective of the tannin content of these barks.

The hide-powder method, on the other hand, is tedious to carry out and often gives abnormal results due to interfering factors; and this method requires the extract of the sample to contain about 4 grams of tannin per liter. Since the tannin content of wood barks varies greatly it is not easy to estimate in advance the approximate tannin content of a particular bark. Often preliminary analyses are necessary to obtain data for an accurate hide-powder analysis. The standard method of preparing the extract and also the temperature control are other troublesome features of the hide-powder method.

The results of our investigation indicate that the most satisfactory method for determining the tannin content of wood barks is to use the permanganate method and refer the results to our permanganate-hide-powder graph, which gives the corresponding figures representing accurate results for the hide-powder method. By analyzing the tree barks in this manner we can obtain accurate data representing results by the modified hide-powder method even though a particular sample analyzed

may contain disturbing substances which do not permit of an accurate analysis by the hide-powder method.

A few years ago Linde and Teufer [5] made by various methods comparative analyses of three wood barks. Their analyses showed that the hide-powder method gave results somewhat higher than the permanganate method. One of the samples they analyzed was pomegranate bark (*Punica granatum* Linn.). We happened to have in our stock room a sample of pomegranate bark obtained from Parke, Davis & Co. We analyzed this sample by the permanganate and the modified hide-powder method. Our results compared with the data obtained by Linde and Teufer for this bark are given in Table 3. The bark we analyzed contained 6.79 per cent moisture. Our results were calculated on a moisture-free basis.

TABLE 3.—*Tannin analyses of pomegranate bark.*

Method used.	Analysis by—	
	Baens and West.	Linde and Teufer.
	Per cent.	*Per cent.*
Permanganate	23.99	22.35
Modified hide-powder	21.03	----------
Hide-powder, corresponding to permanganate results from graph	[a]17.00	----------
Hide-powder	----------	23.8

[a] This figure, representing the result by the hide-powder method, was obtained from the permanganate determination by applying the permanganate-hide-powder graph.

The tannin content of pomegranate bark may vary somewhat due to environmental factors of growth. However, as shown by the data (Table 3) the permanganate method, as we expected, gave for us a higher result (23.99 per cent) than our modified hide-powder method (21.03 per cent). According to our suggestion for ascertaining the tannin percentage from our permanganate-hide-powder graph this sample we analyzed would contain 17 per cent of tannin calculated as gallotannic acid.

SUMMARY

Nine Philippine wood barks were analyzed for tannins by the potassium permanganate method and the modified-hide powder method. With one exception the permanganate method gave much higher results than the hide-powder method.

[5] Pharm. Zentr. 70 (1929) 21 and 53.

The hide-powder method worked smoothly and easily for six of these barks (Nos. 1 to 6, Table 1) which appeared to contain no particular coloring matter or water extractives that would tend to interfere with this method. For this reason we believe the hide-powder method gave the correct tannin content of these barks, two of which gave very positive tests for gallotannic acid.

When the results by the hide-powder and permanganate methods were plotted for these six barks there was obtained a curve (permanganate-hide-powder graph) which was almost a straight line. This indicates that the tannins in these barks have approximately the same reducing power—about equivalent to that of gallotannic acid. Since the tannin content of these barks ranged from a low to a high percentage it would seem that with these barks there is a direct relation between results obtained by the permanganate and modified hide-powder methods.

Three other wood barks (Nos. 7, 8, and 9, Table 2) gave results by the modified hide-powder method which did not coincide with the permanganate-hide-powder graph. Extracts from these barks seemed to contain substances which interfered with the accuracy of the hide-powder method and gave results which appeared to be too high.

From our experiments it would seem that the hide-powder method is very accurate when the extract contains no interfering substances which give abnormally high results. However, in such cases correct data, representing results by the modified hide-powder method, may be obtained by means of the rapid permanganate method and reference to the permanganate-hide-powder graph, which gives the tannin content of the barks as percentage of gallotannic acid. Should the bark contain a tannin having a different reducing power, then the correct result is obtained by multiplying the percentage of gallotannic acid (obtained from the graph) by the proper reduction equivalent factor (if known) for that particular tannin.

The permanganate method is convenient and easy to carry out but gives results that are too high. We are inclined to think that the data we obtained for the first six barks (Table 1) by the hide-powder method afford a means of standardizing the permanganate method. As a result of our experiments it would seem that, by using the permanganate method and referring to the permanganate-hide-powder graph, the exact tannin content of wood barks by the hide-powder method may be deter-

mined. Perhaps this method may be found to be of general application for all kinds of wood barks.

In this paper we have repeatedly referred to our "modified hide-powder method." As a matter of fact the principal difference between the procedure we used for the hide-powder method and the official procedure is in the manner of extracting the bark. We aim to extract only the tannins and leave as much of the nontannins as possible, because the nontannins may contain substances that interfere with the accuracy of the hide-powder method.

ILLUSTRATION

PLATE 1. Graph showing determination of tannin by the hide-powder method and the potassium permanganate method.

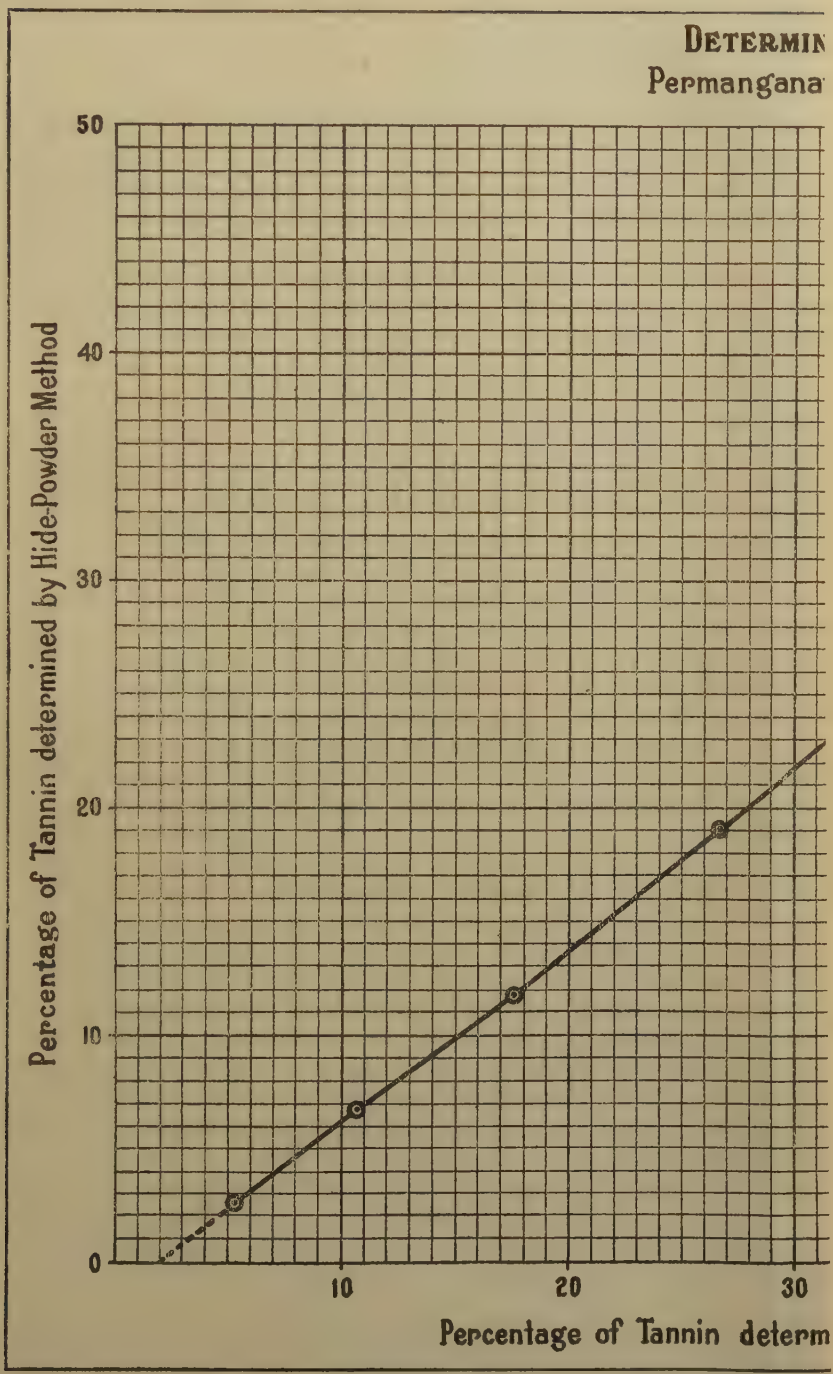
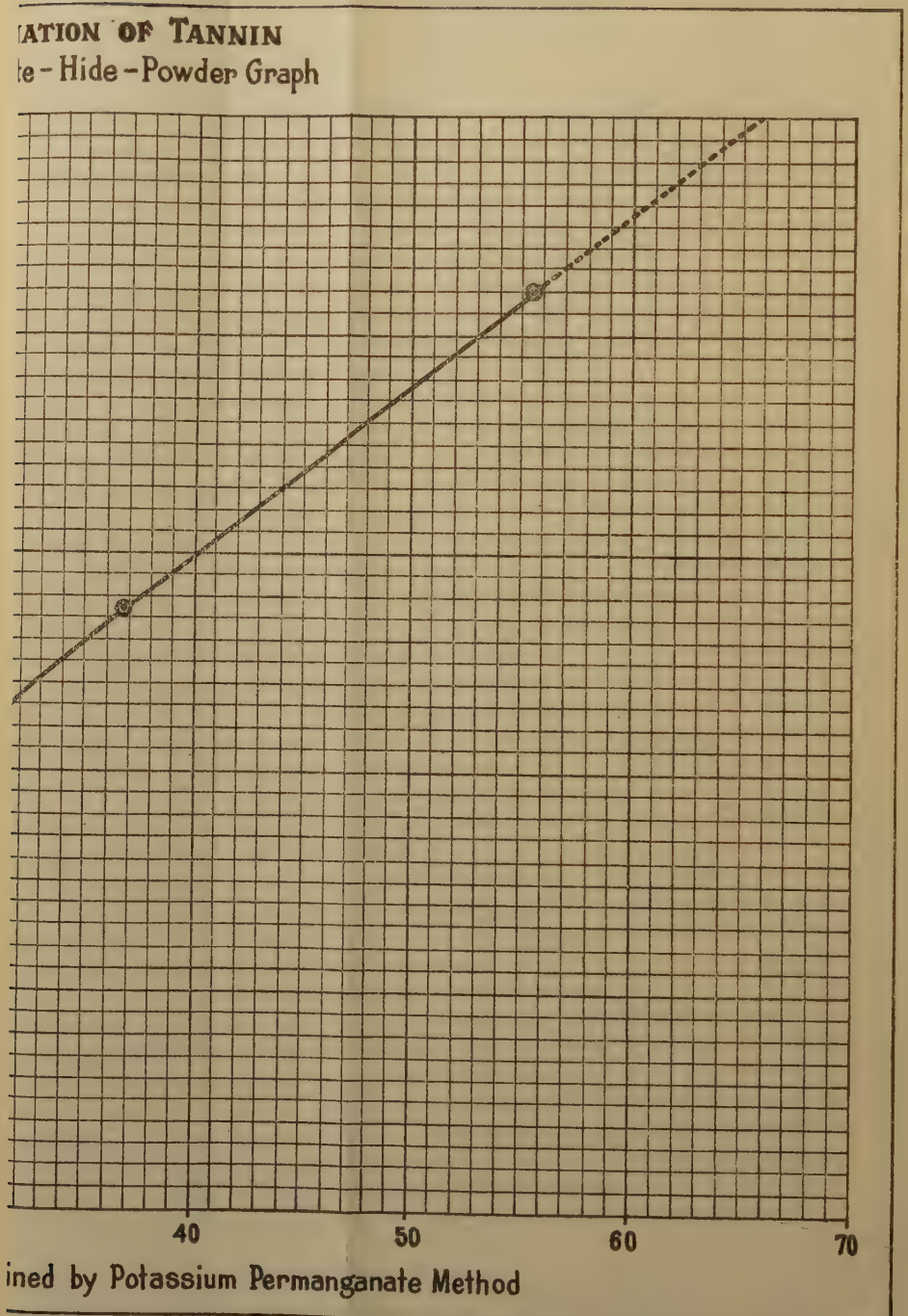


PLATE 1. GRAPH SHOWING THE DETERMINATION OF TANNIN BY THE
GRAPH WAS PLOTTED FRO



HIDE-POWDER METHOD AND THE POTASSIUM PERMANGANATE METHOD. THE
M THE DATA GIVEN IN TABLE 1.

CRYSTALLIZED AND DISTILLED ROSIN FROM PHILIPPINE PINE TREES (PINUS INSULARIS ENDLICHER)

By Simeona S. Tanchico and Augustus P. West

Of the Bureau of Science, Manila

and

P. D. Esguerra

Of the Bureau of Forestry, Manila

ONE PLATE

The Benguet pine (*Pinus insularis* Endlicher) grows extensively in the mountain regions of northern Luzon. Some months ago the resin content of Benguet pine was investigated [1] and the results showed that it yields a turpentine and rosin of high grade. The rosin is obtained in the usual manner by steam distilling the pine resin; the turpentine passes over into the distillate leaving the crude rosin behind. Our experiments have shown that the crude amorphous rosin may be converted by solvents into a crystallized form. When distilled the amorphous rosin is changed into a transparent glassy variety. Data on these different kinds of rosin from Benguet pine trees have been obtained in this investigation.

EXPERIMENTAL PROCEDURE

The pine resin used in making these different kinds of rosin was collected by Rangers J. Fontanoza and P. D. Esguerra, of the Philippine Bureau of Forestry. Data on the resin from a few individual trees and also on a composite sample from twenty-one trees were obtained. Information concerning these pine trees, method of collecting the resin, and quality of turpentine and rosin obtained have been recorded in previous publications.[2]

Crude rosin.—When the pine tree resin is steam distilled turpentine passes over into the distillate leaving the crude, amor-

[1] Santos, I. de, A. P. West, and J. Fontanoza, Philip. Journ. Sci. 45 (1931) 233; 383.

[2] Santos, I. de, A. P. West, and J. Fontanoza, loc. cit.

phous rosin as a residue in the still. Data on the crude amorphous rosin are given in Table 1.

Crystallized rosin.—The crude amorphous rosin, obtained as a residue in steam distilling the pine resin, contained a small amount of impurities such as chips of bark and twigs.

The crude rosin was dissolved in alcohol (95 per cent) and the solution filtered to remove the chips of bark and twigs. A portion of this alcoholic solution was treated with an equal volume of water and shaken vigorously. The alcoholic solution of the rosin separated in two layers—a supernatant milky solution and a lower oily layer. When set aside for about two hours the lower heavy oil gradually changed to a hard mass. The supernatant milky solution was then decanted into another vessel. The hard mass when dissolved in alcohol and treated with an equal amount of water was again partly converted into the milky solution and a lower oily layer which solidified upon standing. By continuing this process the entire amount of the solid material may be converted gradually into a milky solution. When allowed to stand overnight white rosin crystals gradually precipitated out of the milky solution. The crystals were removed by filtering and dried in a vacuum desiccator. The melting point was 118° C. to 122° C. Data on these rosin crystals are given in Table 1.

Distilled rosin.—The crude amorphous rosin obtained as a residue in distilling the Benguet pine tree resin not only contained impurities, such as chips of bark and twigs, but also a small amount of oily substances which were not removed during the steam distillation. This was indicated by the fact that the rosin was not very hard and brittle and showed a tendency to soften and gradually flow. The crude rosin was dissolved in alcohol (95 per cent) and filtered to eliminate the solid impurities. The alcoholic solution was then distilled on a water bath to remove the alcohol after which the residue was distilled in vacuo, using a Crisco oil bath. During the early stage of the distillation the oily substances passed over into the distillate. The rosin distilled over at a temperature ranging from 244° C. to 250° C. with a pressure of about 2 millimeters. The melted rosin in the distillate was poured into paper moulds and, when allowed to cool, the rosin hardened into a brittle, transparent, amber-colored product. Data on the distilled rosin are given in Table 1.

TABLE 1.—*Analysis of rosin from Benguet pine trees (Pinus insularis Endlicher).*[2]

Constants.	Crude rosin, composite sample.	Crystallized rosin, composite sample.	Distilled rosin.			
			Composite sample.	Tree I–A.	Tree II–A.	Tree III–A.
Melting point °C.:						
Softens	98	113	52	55	50	55
Melts	107	118–122	56	60	55	60
Specific gravity $\frac{80°}{4°}$ C.	1.068	----------	1.147	1.075	1.079	1.079
Acid value:						
Titration with aqueous alkali (A)	165.3	180.4	169.25	161.6	158.45	169.4
Titration with alcoholic alkali (a)	161.2	177.7	167.2	154.5	154.2	162.3
Total saponification value (B):	175.9	181.9	177.4	170.5	164.5	172.7
Ester value (B–A)	10.6	1.5	8.15	8.9	6.05	3.3
Ester value (B–a)	14.7	4.2	10.2	16.0	10.3	10.4
Unsaponifiable matter—per cent	6.68	3.19	7.10	9.57	11.23	9.58
Specific rotation A $\frac{80°}{D}$ C.	—26.95	—48.55	—14.91	— 5.9	— 5.55	— 3.81

[2] Tree I–A had deep-furrowed bark. Tree II–A had slightly furrowed bark. Tree III–A had thin, smooth bark. The composite sample was composed of rosin obtained from the resin of twenty-one Benguet pine trees.

As shown by the data (Table 1) the crystallized rosin gave the highest melting point, acid and saponification values. It also gave the lowest ester value, unsaponifiable matter, and specific rotation.

Data on the various samples of distilled rosin (Table 1) showed that this kind of rosin gave a low melting point and specific rotation but a rather high unsaponifiable matter.

Results obtained in a previous investigation [3] showed that different samples of amorphous Benguet rosin gave a wide range in melting points. As samples of the distilled rosin gave a rather narrow range in melting points it would seem that the distilled rosin is a more uniform product.

Samples of abietic acid were prepared from distilled Benguet rosin by using the complex sodium salt method employed by Kessler, Lowy, and Faragher [4] in making abietic acid. The abietic acid from the distilled rosin gave a melting point of 145° to 148° C. The molecular weight calculated from the neutral-

[3] Santos, I. de, A. P. West, and J. Fontanoza, Philip. Journ. Sci. 45 (1931) 383.

[4] Journ. Am. Chem. Soc. 49 (1927) 2898.

ization value was 301.7. The calculated molecular weight of abietic acid ($C_{20}H_{30}O_2$) is 302.2. The distilled rosin gave an abietic acid which seemed to be more stable than the abietic acid prepared from crude rosin as it did not turn yellow on standing.

SUMMARY

Samples of crude, crystallized, and distilled rosin were prepared from Benguet pine trees and analyzed in this investigation.

The crystallized rosin gave the highest melting point. It also gave the lowest ester value and unsaponifiable matter.

The distilled rosin gave a low melting point and specific rotation but a rather high percentage of unsaponifiable matter.

The distilled rosin would appear to be a more uniform product than the crude rosin as it gave a narrow range in the melting point.

Abietic acid prepared from the distilled rosin seemed to be more stable than when prepared from crude rosin.

ILLUSTRATION

PLATE 1. Distilled rosin from Philippine pine trees (*Pinus insularis* Endlicher); transparency shown by the label photographed through the sample.

PLATE 1.

COMPOSITION OF PHILIPPINE RICE OIL (HAMBAS VARIETY)

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and

Nemesio B. Mendiola

Of the University of the Philippines

ONE PLATE

As rice is the staple diet of the inhabitants of the Far Eastern countries the rice bran (polishings) naturally accumulates in considerable quantities as a by-product. The bran comprises the seed coat and germ of the rice grain. It is now used for cattle feed and to a slight extent for making tikitiki extract, which is employed in treating the disease known as beriberi.

Rice oil is obtained from the rice bran. Recently we analyzed Philippine rice oil made from bran of the hambas variety of rice. Our results showed that the oil consists principally of glycerides of oleic, linolic, and palmitic acids and is very similar in composition to kapok, cottonseed, and peanut oil. Rice oil has a bland, fatty taste and according to the composition is suitable for various purposes, such as making edible products and soap, for which cottonseed oil may be employed.

Some years ago the attempt was made to produce rice oil commercially, but Lewkowitsch [1] states that the venture was not successful, due, probably, to the low price of oils and fats which prevailed at that time.

When rice bran is stored the oil in the bran hydrolyzes very rapidly with the production of a considerable quantity of free fatty acids. According to Browne [2] this rapid decomposition of the oil is due to a fat-splitting enzyme-lipase. Experiments carried out by Browne indicated that the fat-splitting enzyme contained in the bran could be destroyed by heating the bran

[1] Chemical Technology and Analysis of Oils, Fats, and Waxes 2 (1922) 330.

[2] Journ. Am. Chem. Soc. 25 (1903) 948.

to a temperature of about 90° C. To prevent the formation of free fatty acids in rice bran and the resulting rancidity Browne suggested heating the bran, immediately after milling, to a dry heat sufficient to destroy the enzyme, such as is done in the kiln-drying of certain seeds.

The hambas rice is a Philippine lowland variety, which has been cultivated at the College of Agriculture, University of the Philippines, for some years. The hambas variety is a fast-growing rice but matures rather late, requiring about two hundred days. It yields from about 40 to 80 cavanes per hectare depending upon the growing conditions. The highest yields are obtained by transplanting the rice.

Hambas rice has rather long grains which have an average length of 8.3 millimeters, an average width of 2.7 millimeters, and an average thickness of 1.9 millimeters.

The flavor of cooked hambas rice is considered somewhat better than that of many other varieties of rice.

EXPERIMENTAL PROCEDURE

The hambas rice used in this investigation was milled under the supervision of Dr. Nemesio B. Mendiola, of the College of Agriculture, University of the Philippines. The bran was sieved and that portion which passed through a 40-mesh sieve was used for this investigation.

The sample of rice oil analyzed was obtained from the rice bran by extracting with ether. The ether extract was then filtered and the filtrate distilled to remove the ether. The rice oil was then treated successively (warming, shaking, and filtering) with kieselguhr, suchar, and talcum powder. The brilliantly clear oil thus obtained had a rather dark brown color with a greenish tinge. The yield for this extract was about 18 per cent calculated on a moisture-free basis. The yield varies naturally from about 14 to 21 per cent depending upon the care with which the bran has been milled.

The physical and chemical constants of this sample of hambas rice oil are given in Table 1.

The percentage of saturated acids was corrected for the amount of unsaturated acids which they contain.

The percentage of unsaturated acids was corrected for the amount contained in the saturated acids and also for the unsaponifiable matter which they contain.

TABLE 1.—*Physical and chemical constants of Philippine rice oil (hambas variety).*

Specific gravity at $\frac{30°}{4°}$C	0.9073
Refractive index at 30° C.	1.4667
Iodine number (Hanus)	99.5
Saponification value	188.1
Unsaponifiable matter (per cent)	3.98
Acid value	40.91
Saturated acids, determined (per cent)[a]	20.52
Unsaturated acids plus unsaponifiable matter, determined (per cent)	73.31
Saturated acids, corrected (per cent)	19.72
Unsaturated acids, corrected (per cent)	70.17
Iodine number of unsaturated acids (determined)	124.6

[a] The lead-salt-ether method does not give an accurate separation of saturated and unsaturated acids.

TABLE 2.—*Separation of saturated acids from the unsaturated acids in Philippine rice oil (hambas variety) by the lead-salt-ether method.*

Experiment No.	Oil used.	Unsaturated acids.	Saturated acids.	Unsaturated acids (determined).	Saturated acids (determined).	Unsaturated acids [a] (corrected).	Saturated acids (corrected).
	g.	*g.*	*g.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	10.0606	7.3629	2.0704	73.19	[b] 20.58	70.01	19.80
2	9.6116	7.0567	1.9659	73.42	[c] 20.45	70.33	19.64
Mean				73.31	20.52	70.17	19.72

[a] Unsaturated acids (with unsaponifiable matter removed), iodine number (Hanus), 124.6.

[b] Iodine number (Hanus), 4.7.

[c] Iodine number (Hanus), 4.9.

The saturated and unsaturated acids that occur as glycerides in the hambas variety of Philippine rice oil were separated by the lead-salt-ether method.[3] The results are recorded in Table 2.

The unsaturated acids separated from hambas rice oil by the lead-salt-ether method were treated with bromine and converted into their bromoderivatives.[4] No ether-insoluble hexabromide

[3] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 1 (1921) 556.

Baughman, W. F., and G. S. Jamieson, Cotton Oil Press 6 (1922) 41; Journ. Am. Chem. Soc. 42 (1920) 2398.

[4] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 1 (1921) 585.

was obtained, thus showing the absence of linolenic acid. The composition of the mixed unsaturated acids, which occur as glycerides in hambas rice oil, was calculated from the iodine number of the unsaturated acids. The results are recorded in Table 3. There are also included the calculated percentages of glycerides corresponding to these individual unsaturated acids.

Saturated acids.—The saturated acids were separated from hambas rice oil by the lead-salt-ether method and esterified with methyl alcohol. The mixed acids were dissolved in methyl alcohol and saturated with dry hydrogen chloride gas. The mixture was then heated on a water bath (reflux) for fifteen hours, after which it was treated with water and the ester layer separated. The esters were dissolved in ether and the ethereal solution washed with sodium carbonate solution and afterwards with water. The ethereal solution was then dehydrated with anhydrous sodium sulphate, filtered, and the ether removed by distilling. The impure esters (103.6 grams), which were yellow, were distilled under diminished pressure. A preliminary distillation at about 5 millimeters pressure was made. The esters

TABLE 3.—*Percentage composition of the unsaturated acids of Philippine rice oil (Hambas variety) and the glycerides corresponding to these acids.*

Acid.	Mixture of unsaturated acids.	Original oil.	Glycerides in original oil.
	Per cent.	*Per cent.*	*Per cent.*
Linolic	37.77	26.50	27.69
Oleic	62.23	43.67	45.64
Total	100.00	70.17	73.33

TABLE 4.—*First distillation of the methyl esters of the saturated acids; pressure, 5 millimeters; 103.6044 grams of esters distilled.*

Fraction.	Temperature.	Weight.
	°*C.*	*g.*
A	145–175	23.2037
B	175–180	23.2015
C	180–187	25.1687
D	187–190	18.3528
E	190–215	11.0922
Residue	----------	2.40
Total	----------	103.4189

(103.4 grams) were then redistilled at 5 millimeters pressure. Data on the distillation of the esters are given in Tables 4 and 5.

In Table 6, are given the analyses of fractions obtained in the second distillation of methyl esters. From the data (Table 6), there were calculated the amounts of the individual acids corresponding to the methyl esters contained in the various fractions. The results are recorded in Table 7.

In Table 8 is given the composition of the mixed saturated acids and the glycerides in the original sample of hambas rice oil corresponding to these acids.

TABLE 5.—*Second distillation of the methyl esters of the saturated acids; pressure, 5.0 millimeters; 103.4189 grams of esters redistilled.*

Fraction.		Temperature.	Weight.
From first distillation.	Second distillation.		
		°C.	g.
A and B	1	165–171	15.6571
C	2	171–176	29.5003
D	3	176–178	21.1298
E	4	178–180	13.5588
Residue	5	180–183	9.9417
	6	183–210	6.7144
	7	210–225	4.9708
Residue			1.90
Total			103.3729

TABLE 6.—*Analyses of fractions obtained in the second distillation of the mixed methyl esters.*[a]

Fraction.	Iodine number.	Saponification value.	Mean molecular weight of mixed esters.	Composition of mixed esters.		Mean molecular weight of saturated esters.
				Saturated.	Unsaturated.	
				Per cent.	*Per cent.*	
1	1.4	209.0	268.4	98.82	1.18	268.2
2	1.9	206.7	271.4	98.40	1.60	271.0
3	2.8	206.5	271.7	97.64	2.36	271.1
4	5.0	204.8	273.9	95.79	4.21	273.1
5	8.9	202.8	276.6	92.50	7.50	275.3
6	13.8	192.9	290.8	88.37	11.63	290.2
7	9.8	165.1	339.8	91.74	8.26	344.4

[a] Calculated iodine number of unsaturated methyl esters was 118.7. Calculated saponification value of unsaturated methyl esters was 190.0.

TABLE 7.—*Saturated acids corresponding to methyl esters in each fraction.*

Fraction.	Acid.									
	Myristic.		Palmitic.		Stearic.		Arachidic.		Lignoceric.	
	P. cent.	*g.*	*P. cent.*	*g.*	*P. cent.*	*g.*	*P. cent.*	*g.*	*P. cent.*	*g.*
1	6.95	1.09	86.70	13.57						
2			90.97	26.84	2.34	0.69				
3			89.94	19.00	2.66	0.56				
4			81.74	11.08	9.13	1.24				
5			72.06	7.16	15.75	1.57				
6			24.25	1.63	59.85	4.02				
7							59.47	2.96	28.52	1.42
Residue [a]										1.83
Total		1.09		79.28		8.08		2.96		3.25

[a] Residue assumed to be methyl lignocerate.

TABLE 8.—*Saturated acids.*[a]

Acid.	Mixture of saturated acids.			Glycerides in original oil.
	Weight.	Composition.	Proportions in original oil.	
	g.	*Per cent.*	*Per cent.*	*Per cent.*
Myristic	1.09	1.15	0.22	0.23
Palmitic	79.28	83.75	16.51	17.32
Stearic	8.08	8.54	1.68	1.76
Arachidic	2.96	3.13	0.62	0.65
Lignoceric	3.25	3.43	0.68	0.70
Total	94.66	100.00	19.71	20.66

[a] When separated from rice oil the corrected percentage of saturated acids was 19.71.

The composition of hambas rice oil is given in Table 9. There is also included for comparison the composition of a sample of rice oil analyzed by G. S. Jamieson.

In Table 10 is given the composition of Philippine rice oil (hambas) compared to other Philippine and American oils. As shown by the data the rice oil is very similar in composition to kapok, cottonseed, and peanut oils. All of these oils consist principally of glycerides of oleic, linolic, and palmitic acids. They are suitable commercially for the various purposes for which cottonseed oil is employed; that is, the high-grade oils are useful for making edible products, while the lower grades may be employed in soap making.

TABLE 9.—*Composition of rice oil.*

Constituent.	Philippine rice oil (hambas variety).	Rice oil [a] analyzed by G. S. Jamieson.
Glycerides of:		
Unsaturated acids—		
Oleic	45.6	41.0
Linolic	27.7	36.7
Saturated acids—		
Myristic	0.2	0.3
Palmitic	17.3	12.3
Stearic	1.8	1.8
Arachidic	0.7	0.5
Lignoceric	0.7	0.4
Unsaponifiable matter	4.0	4.6
Total	98.0	97.6

[a] This oil was an ether extract of rice bran made by C. E. F. Gersdorff, of the Bureau of Chemistry, Washington.

TABLE 10.—*Comparison of Philippine rice oil (hambas) with other oils.*

Constituent.	Philippine oils.			American oils.	
	Rice oil (hambas).	Kapok-seed oil. [a]	Peanut oil. [b]	Cotton-seed oil. [c]	Peanut oil. [d]
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Glycerides of:					
Unsaturated acids—					
Oleic	45.6	49.8	53.9	35.2	52.9
Linolic	27.7	29.3	27.0	41.7	24.7
Saturated acids—					
Myristic	0.2	0.5	----------	0.3	----------
Palmitic	17.3	15.9	8.5	20.0	8.2
Stearic	1.8	2.3	3.6	2.0	6.2
Arachidic	0.7	0.8	3.4	0.6	4.0
Lignoceric	0.7	--------	2.4	----------	3.1
Unsaponifiable matter	4.0	0.8	0.3	----------	0.2
Total	98.0	99.4	99.1	99.8	99.3

[a] Philippine kapok-seed oil (*Ceiba pentandra* Gaertner), analyzed by A. O. Cruz and A. P. West, Philip. Journ. Sci. 46 (1931) 131.

[b] Philippine peanut oil (Valencia variety), analyzed by A. O. Cruz and A. P. West, Philip. Journ. Sci. 46 (1931) 199.

[c] American cottonseed oil, analyzed by G. S. Jamieson and W. F. Baughman, Journ. Am. Chem. Soc. 42 (1920) 1197.

[d] American peanut oil (Spanish type), analyzed by G. S. Jamieson, W. F. Baughman, and D. Brauns, Journ. Am. Chem. Soc. 43 (1921) 1372.

The commercial possibilities of rice oil would depend upon the current price and available supply of other oils such as coconut, cottonseed, etc. In case of scarcity of these other oils rice oil may become a commercial product of considerable importance.

A serious drawback to the commercial development of the rice oil industry is that the oil is not easily expressed from the bran. Recently we tried to express the oil from rice bran by using a hydraulic press of the coconut oil mill of the Spencer, Kellogg Company. With a pressure of 4,000 pounds, which is commonly employed for expressing coconut oil, practically no oil was obtained from rice bran. To produce rice oil commercially it would seem that an extraction plant would be necessary.

The authors wish to thank Mr. H. Hellis of the Spencer, Kellogg Company who very kindly permitted us to use a hydraulic press.

SUMMARY

Rice oil is obtained from rice bran which comprises the seed coat and germ of the rice grain.

In this investigation we determined the composition of rice oil obtained from bran of the hambas variety of rice. Our results showed that this kind of rice oil consists principally of glycerides of oleic, linolic, and palmitic acids.

Hambas rice oil is very similar in composition to kapok, cottonseed, and peanut oils. These oils are suitable commercially for the manufacture of edible products and soaps and for other purposes for which cottonseed oil may be employed.

To produce rice oil commercially it would seem that an extraction plant would be necessary.

Rice oil may be an additional source of income for the rice industry.

ILLUSTRATION

PLATE 1. Hambas variety of rice.

PLATE 1. HAMBAS VARIETY OF RICE.

OBSERVATIONS ON THE LIFE HISTORIES OF EUPARYPHIUM MURINUM TUBANGUI, 1931, AND ECHINOSTOMA REVOLUTUM (FROELICH, 1802), (TREMATODA)

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THREE PLATES

INTRODUCTION

In February, 1931, samples of a non-operculated, fresh-water snail, *Lymnaea peregra* (Müller),[1] obtained from an irrigation canal that runs through the cultivated fields and pasture grounds of the Trinidad Agricultural School near Baguio, Mountain Province, Luzon, were examined for larval trematodes. About three per cent of the snails were found infested with characteristic echinostome larvæ which, due to their almost uniform behavior and external appearance, were regarded to represent a single species. When, however, the encysted metacercariæ were fed to two white laboratory rats and to a young house pigeon, specimens of two species of adult echinostome flukes armed with thirty-seven and forty-five cephalic spines, respectively, were recovered as a result of the feeding experiment. In view of this, additional lots of the same kind of snail from Trinidad Valley were secured for further studies.[2] Fortunately, what appeared to be the same kinds of trematode larvæ were again encountered, and when the encysted metacercariæ were given to another series of animals (one rat and one young pigeon), identical results were obtained; namely, the recovery from the experimental animals of two species of adult echinos-

[1] This snail (Plate 2, fig. 6) was identified by Dr. H. A. Pilsbry, of the Academy of Natural Sciences, Philadelphia, to whom shells were forwarded through the courtesy of Dr. D. Villadolid, of the College of Agriculture, University of the Philippines.

[2] I wish to express my appreciation to Dr. Cleto Vibar, of the Trinidad Agricultural School, for kindly supplying some of the snails used in these observations.

tomes morphologically similar to those collected in the first experiment.

In order to check up the results, a careful study of the larvæ was made. It was found that the snails in question were infested with two types of echinostome larvæ that resemble each other very closely and can only be differentiated by the number of spines present on their head collars. The cercariæ and metacercariæ of one type of larvæ are armed with thirty-seven cephalic spines, the number and arrangement of which correspond to those of the cephalic spines of one of the two species of adult echinostomes developed experimentally; those of the other type of larvæ are provided with forty-five cephalic spines, also similar in their number and arrangement to the cephalic spines of the other species of adult fluke. After this finding, it was only necessary to plan a final series of controlled feeding experiments in order to obtain incontrovertible evidence concerning the true nature of these larval trematodes. This was done as follows: In previous experiments several infested snails were mixed in one container and the mixture divided among several animals so that it was not known what kind of cysts a particular animal received. In this series each experimental host was fed with only one infected snail which, as far as it was possible to ascertain, harbored only one type of cysts. Satisfactory results were obtained. The metacercariæ armed with thirty-seven cephalic spines developed in the intestines of susceptible animals into adult echinostomes armed with the same number of cephalic spines and those with forty-five spines into adults with a corresponding head armature.

SUMMARY OF FEEDING EXPERIMENTS

The rats employed in the experiments recorded below were fed with a ration consisting of white bread, uncooked camote tubers, and lettuce leaves, and the pigeons with unboiled rice, uncooked mongo beans, and lettuce leaves. None of these different articles of food could have been responsible for any of the positive infestations obtained, as otherwise control and other animals fed on the same rations would have been found similarly infested. It is therefore certain that the resulting infestations were due to the feeding of the animals with snails harboring encysted metacercariæ.

Experiment 1.—February 24, 1931. Bodies of five *Lymnaea* snails harboring encysted metacercariæ cut together into small pieces and fed by means of a medicine dropper to rats 1 and 2, pigeon 1, and one monkey. Fæces of each animal examined every other day for trematode eggs.

March 6. Rats 1 and 2 showed trematode eggs in fæces. Rat 1 killed and from its small intestine three full-grown specimens of a small echinostome (*Euparyphium murinum*) each armed with forty-five cephalic spines were collected. Rat 2 was allowed to live and up to March 25 its fæces were positive for fluke eggs. March 27, or two days later, they were negative, and when the animal was killed no flukes were found in the intestinal tract.

March 8. Pigeon 1 positive. On the morning of March 13 it was found dead inside its cage and on autopsy thirty-three mature specimens of a medium-sized echinostome (*Echinostoma revolutum*), each armed with thirty-seven cephalic spines, were collected from the proximal portion of the large intestine.

March 18. Fæces of monkey negative up to this day.

Experiment 2.—April 14. Three infected snails divided between rat 3 and pigeon 2.

April 27. Rat 3 positive. Killed April 29 and yielded seven adult *Euparyphium.*

April 29. Pigeon 2 positive. Killed and yielded sixteen adult *Echinostoma.*

Experiment 3.—May 17. Rat 4 and 5 and pigeon 3 each fed one snail harboring encysted metacercariæ armed with forty-five cephalic spines; rat 6 and pigeon 4 with cysts armed with thirty-seven cephalic spines. Rat 7 and 8 kept in the same cage as rat 4 and 5 as controls; pigeon 5 in the same cage as pigeon 3 and also used as control.

May 29. Rat 5 positive. Killed and yielded two adult *Euparyphium.*

May 30. Pigeon 4 positive. Killed and yielded seventeen adult *Echinostoma.*

June 1. Rat 4 positive. Killed and yielded five adult *Euparyphium.*

June 9. Rats 6, 7, and 8 and pigeons 3 and 5 negative up to this day. Killed and found free of flukes.

MORPHOLOGY OF EUPARYPHIUM MURINUM DURING DIFFERENT STAGES OF ITS DEVELOPMENT

Larval stages found in snails.—The cercaria of *Euparyphium murinum* (Plate 2, fig. 4) possesses the characteristic echinostome appearance and behaviour. In the fully developed state it is very active and is a good swimmer. During swimming the body is curled ventrally and is propelled by the vigorous lashing of the tail. If prevented from swimming, as when it is compressed under a cover glass or when the tail becomes detached from the body, movement is accomplished by the alternate attachment of the two suckers to the substratum.

The cercaria is capable of extreme contraction and extension, hence it is difficult to measure accurately in the living state. The measurements given below are based on stained, moderately extended specimens mounted in balsam. Body elongate, its lateral margins nearly parallel, broadly attenuated anteriorly, with a slight median depression at its posterior end where the tail is attached; it measures 0.32 to 0.40 by 0.08 to 0.10 millimeter. Tail measures 0.38 to 0.40 millimeter in length by 0.035 to 0.040 millimeter in maximum width near its base; it gradually narrows to a point towards its posterior end. Cuticle of body thickly covered with very minute spines. Beneath cuticle are numerous, roundish to pyriform cystogenous cells, 8 to 16 microns in diameter, filled with opaque granular material, due to which several important internal structures, especially the small excretory vessels, are obscured from view. Head collar prominent, reniform, 0.075 to 0.083 millimeter across. It bears forty-five spines, the arrangement of which is quite identical with the arrangement of the cephalic spines of the adult stage of the worm; the spines measure 13.3 to 22.0 by 3.3 to 4.5 microns, the size depending upon the age of the cercariæ, the young forms possessing smaller needle-shaped spines. Oral sucker subterminal to terminal, 0.033 to 0.041 millimeter in transverse diameter; acetabulum behind middle of body length, slightly larger than oral sucker, 0.045 to 0.058 millimeter across. Mouth ventroterminal, on the dorsal lip of which are found the terminals of four pairs of ducts, leading probably from salivary glands, the position of which was not ascertained; pharynx 0.016 to 0.020 by 0.014 to 0.016 millimeter in size, separated from oral sucker by prepharynx 0.012 to 0.016 millimeter long; œsophagus 0.104 to 0.154 millimeter long, made up of a column of finely granular cells and bifurcates immediately in front of acetabulum; intestinal cæca simple, also composed of columns of cells, pass on each side of acetabulum and reach to near posterior end of body.

Reproductive system represented by two pyriform masses of cells, one slightly anterior and the other posterior to acetabulum, connected by a longitudinal strand of cells.

Excretory system typically echinostome in arrangement. Excretory bladder small, oval, median, at posterior end of body; it is sometimes divided into two portions by a transverse constriction and opens to exterior through a small median pore on dorsal surface of body at point of attachment of tail. A longi-

tudinal caudal collecting tube arises from posterior end of bladder and extends to near tip of tail, where it apparently ends blindly; near its proximal end this tube gives off a pair of lateral branches that open outside through lateral openings. Two main collecting tubes that are conspicuous due to their size and to the large fatlike globules which they inclose arise from anterolateral regions of bladder; these follow a slightly wavy course lateral to intestinal cæca and œsophagus and on reaching the level of pharynx each tube bends towards median line, forms a loop and is continued posteriorly as a small collecting tubule. The latter on reaching the level of excretory bladder forms another loop and apparently takes an anterior course. Due to the presence of the opaque cystogenous cells already referred to, it was not possible to trace the minute excretory vessels or capillaries. It is believed, however, that the flame cells found, of which there are twenty-two on each side of the body, or a total of forty-four, and which are distributed as shown in Plate 2, fig. 4, represent the total number possessed by this cercaria.

This cercaria like other echinostome cercariæ develops in rediæ, of which two kinds were encountered in the digestive and rarely in the reproductive glands of infested snails; namely, young immature forms with only germ cells and mature forms inclosing germ balls, cercariæ, and sometimes encysted metacercariæ. The young rediæ (Plate 2, fig. 2) differ from the mature rediæ by their small size and active movements. They are bluntly rounded anteriorly, somewhat attenuated posteriorly, and measure 0.34 to 0.42 by 0.07 to 0.08 millimeter. They possess near the anterior end a conspicuous collar and near the posterior end a pair of blunt locomotor appendages. To one side of the body behind the collar is found a birth pore. The mouth is anteroterminal and is followed first by a prominent pharynx 0.037 to 0.050 by 0.040 to 0.045 millimeter in size and then by a rhabdocœle gut that may extend posteriorly up to the level of the locomotor appendages. The excretory system appears to consist of two clusters of flame cells with their ducts, the course of which was difficult to determine. There were seen a group of five flame cells near the level of the locomotor appendages and another group of the same number of cells in the middle of the body length.

The mature rediæ (Plate 2, fig. 3) are essentially similar in structure to the young ones. They are less active and often

they do not exhibit any movement at all. They are usually colored with a brownish tinge. Their usual appearance is, as aptly described by Lebour (1908) and by Johnson (1920) for the rediæ of related cercariæ, that of a stocking viewed from the side, the locomotor appendages being at the angle of the stocking. They are filled with five to eighteen cercariæ in different stages of development, besides an equally variable number of germ balls and sometimes encysted metacercariæ. They measure 1.30 to 1.80 by 0.20 to 0.24 millimeters. The pharynx is 0.062 to 0.087 by 0.030 to 0.040 millimeter in size. The rhabdocœle gut is relatively very short and is often pushed to one side by the inclosed cercariæ.

The cercariæ of the majority of digenetic trematodes in the fully developed state leave their molluscan intermediate hosts in order to swim freely in the water and seek opportunities that will enable them to enter into their final hosts. The cercaria of *Euparyphium murinum*, however, like that of *Echinostoma revolutum* and related echinostomes, seems to lead, if at all, only a very brief free-living existence; for it is capable of encysting within its redia or in the tissues of its snail host immediately after issuing from its redia. The process of encystment is accomplished by the liberation of the contents of the cystogenous cells. The secretion collects around the body surface and on hardening forms an efficient protective envelope for the inclosed larva which has cast off its tail preparatory to encystment. It is now known as a metacercaria or adolescaria and represents the infective stage of the life cycle. It does not differ essentially in structure from the cercaria. The cysts (Plate 2, fig. 5) are spherical and are 145.6 to 185.0 microns in diameter. The cyst wall is 6 to 12 microns in thickness and consists of two layers—a thick, external, gelatinous layer and a thin, membranous, internal layer.

Adult stage.—The adult stage (Plate 1, fig. 1) possesses the characters assigned to the genus *Euparyphium* Dietz, 1909, and is probably identical with *Euparyphium murinum* Tubangui, 1931, described from wild rats. A comparison of the two sets of specimens has revealed no significant difference, except in the position of the cirrus sac. In the type specimens from a wild rat the cirrus pouch often extends posteriorly much beyond the equator of the acetabulum. In those from the experimental white rats it rarely reaches the equator of the acetabulum; in

the majority of cases the bulk of the organ is found anterior to the ventral sucker. In view of the taxonomic significance attached to the location of this structure, especially in the family of trematodes to which this parasite belongs, the difference may be considered of sufficient importance to place the experimental flukes in a separate species. It is now recalled, however, that the type specimens of *Euparyphium murinum* were collected from a rat that had been dead for at least twenty-four hours and were in a semidecomposed state when preserved. It is possible, therefore, that the loss of muscle tonus and other factors accompanying the process of decomposition might have had something to do with the seemingly abnormal position of the cirrus pouch. The brief description following is based on specimens from experimental rats:

Body small, elongate, 3.65 to 5.00 by 0.50 to 0.60 millimeters in size; lateral margins from behind cephalic collar to acetabulum slightly inrolled ventrally. Cuticle armed with prominent spines, ventrally from anterior end to level of second testis and dorsally from anterior end to acetabulum. Head collar reniform, 0.20 to 0.28 millimeter across, armed with forty-five spines arranged as follows: Five corner ventral spines on each side, more or less bunched together and measuring 35.3 to 41.6 by 7.9 to 8.3 microns; thirty-five marginal spines arranged in two alternating rows and measuring 35.3 to 45.7 by 8.3 to 9.1 microns. Oral sucker 0.08 to 0.12 by 0.09 to 0.12 millimeter in size; pharynx 0.09 to 0.12 by 0.08 to 0.09 millimeter, separated from oral sucker by very short prepharynx; œsophagus 0.10 to 0.14 millimeter long, bifurcates about midway between pharynx and acetabulum; intestinal cæca simple, reach to near posterior end of body. Acetabulum 0.28 to 0.36 millimeter in diameter, usually at middle of anterior fourth of body length.

Testes tandem, postovarial, at third fourth of body length, with smooth borders or constricted at middle into anterior and posterior lobes; first testis usually smaller, measuring 0.42 to 0.48 by 0.17 to 0.24 millimeter; posterior testis 0.50 to 0.64 by 0.18 to 0.26 millimeter. Cirrus sac oval, 0.20 to 0.40 by 0.12 to 0.16 millimeter in size, rarely reaching posteriorly to equator of acetabulum, its greater bulk in the majority of cases being found in front of the ventral sucker; incloses prominent seminal vesicle, pars prostatica, and protrusible cirrus. Common genital opening near median line, immediately behind œsophageal bifurcation.

Ovary slightly oval, preëquatorial, 0.18 to 0.25 by 0.16 to 0.20 millimeter in size. Shell gland larger than ovary, between latter and anterior testis; receptaculum seminis absent, Laurer's canal present. Uterus short, between intestinal cæca, ovary, and acetabulum, filled with few eggs. Vitellaria in large distinct follicles, extending from about midway between acetabulum and ovary to posterior end of body; they are extracæcal anteriorly but behind second testis follicles of two sides unite in median line and occupy most of the space in this region of the body.

Main portion of excretory system typically echinostome in arrangement. Excretory bladder moderately long, with five pairs of lateral branches that ultimately break up into capillaries; it opens outside through a median, posteroterminal, excretory pore. Behind the second testis the bladder divides into two principal branches, the main collecting tubes, which follow a more or less straight course towards the anterior end; on reaching the level of the pharynx each tube makes a loop and turns posteriad. It was not possible to trace the smaller excretory vessels, but there were counted sixty-six flame cells on each side of the body, the distribution of which is shown in Plate 1, fig. 2.

The eggs are oval, yellowish, operculated at one pole; egg shell thin throughout except at nonoperculated pole where there is a slight thickening; they measure in the fresh state 79.0 to 95.6 by 54.0 to 66.5 microns and are in the one-cell stage when evacuated with the fæces of the host. The progress of their development was not watched day by day but it was determined, if left in a suitable container with a small amount of tap water at room temperature (25° to 31° C.), that they attain the miracidial stage after seven to ten days.

The mature miracidium (Plate 2, fig. 1) almost completely fills the entire space within the eggshell except what is occupied by two or three large fatlike globules that probably represent the remnant of the yolk material originally found surrounding the embryo. It has a characteristic appearance, its anterior end being produced into a small retractile process devoid of cilia. The rest of the body surface is covered with longitudinal rows of long cilia, with which the organism is enabled to swim in the water when it escapes from its shell. A conspicuous eyespot is present in the median line near the anterior end. Like other miracidia, it possesses a primitive sacculate gut, a pair of secretory glands and a number of germinal cells. The excretory system is represented by two flame cells, one on

each side of the median line near the equator of the body. Each cell is provided with a duct that leads to the exterior through a marginal opening. No attempt was made to observe the early behavior of the miracidium in the body of its molluscan host.

MORPHOLOGY OF ECHINOSTOMA REVOLUTUM DURING DIFFERENT STAGES OF ITS DEVELOPMENT

The adult stage of this parasite has been described from wild and domestic ducks, as well as from the goose, fowl, pigeon, and various wild aquatic birds, by many authors, notably by Looss (1899) in Egypt, Dietz (1910) in Europe, Johnson (1920) in North America, and Lutz (1924) in South America. It was recently reported by Tubangui (1931) from a Philippine domestic duck. Its experimental development in pigeons is of interest in connection with the question raised by Krause (1925*b*) on the identity of a fluke, *Echinostoma columbae*, described by Zunker (1925) from a house pigeon in Germany. Krause (1925*a*) had previously reported an echinostome which was the cause of an epizoötic among domestic pigeons in Germany and which he believed to be identical with *Echinostoma revolutum*. According to him, his specimens are similar to those described by Zunker; hence, he would consider *Echinostoma columbae* as a synonym of *Echinostoma revolutum*.

The life history of or, at least, the mode of infestation with this trematode has recently been studied by Johnson (1920) and by Lutz (1924). The snails that have been determined to play the rôle of intermediate hosts and to which should now be added *Lymnaea peregra* are *L. stagnalis*, *Physa occidentalis*, and *P. rivalis*. The following account of the different stages of the life cycle of the parasite is, therefore, necessarily brief and is intended mainly for comparison with that of *Euparyphium murinum* and with Johnson's observations.

Larval stages found in snails.—The cercaria of *Echinostoma revolutum* is very similar to that of *Euparyphium murinum* and, as already stated, can only be distinguished from it with certainty by the number of its collar spines. In moderately extended, stained specimens mounted in balsam the body measures 0.33 to 0.52 by 0.15 to 0.25 millimeter; tail 0.40 to 0.48 by 0.037 to 0.050 millimeter. Entire body surface thickly covered with very minute spines. Cephalic collar 0.090 to 0.125 millimeter across, bears thirty-seven spines arranged in two

alternating rows and measuring 10.4 to 12.5 by 2.0 to 3.0 microns. Oral sucker 0.054 to 0.062 by 0.050 to 0.062 millimeter in size; pharynx 0.025 to 0.030 by 0.020 to 0.027 millimeter, separated from oral sucker by very short prepharynx; œsophagus 0.095 to 0.145 millimeter long, bifurcates in front of acetabulum into two intestinal cæca that extend to near posterior end of body. Acetabulum behind middle of body length, 0.058 to 0.075 by 0.062 to 0.083 millimeter in size.

Genital anlage very similar in appearance and location to that of *Euparyphium murinum*. Main portion of excretory system also similar to that of latter in arrangement. Due to scarcity of material and to the presence of numerous cystogenous cells in the body, I was unable to trace the smaller excretory vessels and the distribution of the flame cells.

Development also takes place in rediæ that are difficult to distinguish from the corresponding stages of *Euparyphium murinum*. The active, young rediæ measure 0.32 to 0.46 by 0.08 to 0.10 millimeter, the mature ones 0.72 to 1.90 by 0.16 to 0.25 millimeters. The pharynx in both forms is globular and of about the same size, measuring 0.033 to 0.041 millimeter in diameter.

The encysted metacercariæ are spherical, 150 to 160 microns in diameter; the cyst wall is 5 to 9 microns in thickness. They were found most abundantly in the connective tissues of the liver and reproductive organs of infected snails; occasionally they occur in small numbers inside the mature rediæ. They can only be distinguished from the metacercariæ of *Euparyphium murinum* by counting the number of the collar spines.

Adult stage.—Total length of mature worms (Plate 3, fig. 1) from experimental pigeons 4.50 to 9.30 millimeters; maximum breadth 1.05 to 1.65 millimeters, behind acetabulum; lateral margins of body from behind collar to acetabulum inrolled ventrally. Cuticle armed with prominent spines, dorsally from anterior end to acetabulum and ventrally from anterior end to level behind second testis. Head collar 0.50 to 0.70 millimeter across, armed with thirty-seven principal spines and, in some cases, a variable number (1 to 3) of accessory spines. Principal collar spines arranged as follows: Five corner ventral spines on each side more or less bunched together, measuring 66.5 to 91.5 by 14.5 to 17.8 microns, the first two inner spines on both sides being usually smaller; twenty-seven marginal spines arranged in two alternating rows, uninterrupted dor-

sally, more or less uniform in size, measuring 79.0 to 99.8 by 16.5 to 20.8 microns. Accessory spines 30.0 to 41.6 by 8.0 to 12.0 microns in size, usually among principal corner spines. Oral sucker 0.22 to 0.30 by 0.22 to 0.28 millimeter in size; pharynx 0.20 to 0.24 by 0.16 to 0.20 millimeter; prepharynx very short; œsophagus 0.32 to 0.40 millimeter long, bifurcates in front of acetabulum; intestinal cæca simple, reach to near posterior end of body. Acetabulum measures 0.74 to 0.80 by 0.70 to 0.80 millimeter; in large extended specimens it is located behind middle of anterior fourth of body length, while in small contracted specimens at junction of first and second fourth of body length.

Testes tandem, postovarial in third fourth of body length; shape variable—elongate and with smooth borders or with transverse constriction at middle; or shorter and with transverse constriction or divided into three to five lobes each; anterior testis usually smaller, measuring 0.28 to 0.70 by 0.26 to 0.54 millimeter, posterior testis 0.34 to 0.84 by 0.28 to 0.46 millimeter. Cirrus sac 0.36 to 0.44 by 0.20 to 0.36 millimeter in size, in front of equator of acetabulum, its greater bulk between this organ and œsophageal bifurcation; incloses seminal vesicle, pars prostatica, and protrusible cirrus. Common genital opening median or slightly to one side of median line, preacetabular, almost directly ventral to œsophageal bifurcation.

Ovary slightly compressed, median, almost equatorial, measuring 0.18 to 0.32 by 0.20 to 0.40 millimeter. Shell gland as big as or even larger than ovary, usually median and between ovary and first testis, but sometimes displaced slightly anteriorly and to one side of median line; receptaculum seminis absent, Laurer's canal present. Uterus moderately developed, containing many eggs. Vitellaria in moderately large follicles, from posterior level of acetabulum to near posterior end of body; the follicles of the two sides are usually separate throughout, but in rare cases they become confluent behind second testis.

Main portion of excretory system similar in arrangement to that of *Euparyphium murinum*. The excretory bladder, however, is much longer and is often slightly coiled at its posterior portion. I was unable to trace the smaller excretory vessels, but there were counted sixty-three pairs of flame cells, the distribution of which is shown in Plate 3, fig. 2.

The eggs have the same shape and color as those of *Euparyphium murinum;* they measure in the fresh state 89.5 to 108.0

by 58.2 to 70.5 microns. Kept in water at room temperature (25° to 31° C.), they attained the miracidial stage after seven to nine days.

DISCUSSION

It is evident from the descriptions that there are no fundamental differences in the life histories of the two echinostomes studied. In conformity with the known sequence of development of digenetic trematodes in general, the various stages of their life cycles may be rearranged as follows: Egg, miracidium, redia, cercaria, encysted metacercaria, and adult. They both agree, therefore, with other echinostomes in the absence of sporocyst stages, their miracidia after gaining entrance into the body of their molluscan intermediate hosts apparently developing directly into rediæ. Other trematodes, such as the blood flukes, lack the redial stage instead and, according to Sewell (1922), the omission is made good by the production of secondary sporocysts from the primary sporocysts. In the case of echinostomes and other flukes that do not pass through a sporocyst cycle, the omission may also be compensated by the production of a succession of redial stages. In the present observations no evidence of this mode of substitution was seen, but Johnson (1920) in his studies on the life history of *Echinostoma revolutum* described what he termed "mother- and daughter-rediæ," the latter developing from the former.

According to Faust (1929), Johnson (1920), Lebour (1908), and Lutz (1924), the cercariæ of some echinostomes encyst within their rediæ or in the tissues of their intermediate hosts after the escape of the cercariæ from the rediæ; others leave their molluscan hosts and encyst in water, on plants, in planarians, in other mollusks, or in the bodies of lower vertebrates, such as, fishes and tadpoles. The occurrence of the encysted metacercariæ of *Echinostoma revolutum* and *Euparyphium murinum* within their rediæ and in the tissues of their molluscan hosts has been mentioned. In addition, observations were made in order to determine if the cercariæ of the two parasites are also capable of encysting in water, but only negative results were obtained. In every instance there was observed under the microscope a liberation of the secretion of the cystogenous glands around the body surface of a cercaria, but the resulting cyst wall appeared weak and soft and the inclosed larva looked degenerate and ready to disintegrate. It is possible that the

cercariæ on which the observations were made were not fully mature and, therefore, were not yet ready to encyst. To check this, samples of water containing snails that later were found infested were examined repeatedly after being centrifuged, but at no time were cysts encountered.

From the standpoint of infection, only the encysted metacercariæ of these two parasites are capable of developing into adult worms if fed to suitable vertebrate hosts. This is true of the large majority of digenetic trematodes. In the case of the metacercaria of *Echinostoma revolutum*, judging from the results of the feeding experiments, development to adulthood was observed to take place only in pigeons. It was unable to infect rats and a monkey, so that it would seem that it is strictly a bird parasite. In fact, as already mentioned, it has been reported from various kinds of birds but never yet from a mammal. On the other hand, the metacercaria of *Euparyphium murinum* developed in rats but not in the other experimental animals. Whether or not, however, it is capable of infesting other hosts, can only be decided by more feeding tests.

It is generally believed that there exists a specific resemblance between echinostome cercariæ and their adults with regard to the number of spines on their head collars. The results of the present study sustain this view, for it was shown that both the cercaria and the adult form of *Echinostoma revolutum* possess thirty-seven cephalic spines and the corresponding stages of *Euparyphium murinum* forty-five spines. Johnson (1920), on the other hand, counted forty-three spines on the collar of the cercaria of *Echinostoma revolutum* and only thirty-six to thirty-seven on that of the adult. He explained the reduction in the number of spines from cercaria to adult as due to "the ease with which any of the spines can be lost unless the worms are handled very carefully, and the fact that there is not enough room on the collar for more spines." On the basis of the present observations and of what is generally believed, it is perhaps more probable that he described the cercaria of a different species of echinostome.

Due to the difficulties involved, it was not possible to trace the fine excretory tubules that connect the flame cells with the principal excretory vessels for either *Echinostoma revolutum* or *Euparyphium murinum*. It is believed that the total numbers and distribution of the flame cells have been determined in the adult of *Echinostoma revolutum* and in the cercaria and adult

of *Euparyphium murinum*. In the case of the latter parasite, the cercaria possesses twenty-two pairs of flame cells and the adult sixty-six pairs. The increase in the number of the cells in the adult is no doubt due to the multiplication of the excretory cells of the cercaria during its growth into adulthood. Such a process of multiplication in a manner that the total number of flame cells in the adult is an exact multiple of those originally present in the cercaria is supposed to take place in all digenetic flukes (Faust). In this case the multiple is "3." In *Echinostoma revolutum*, the adult of which possesses sixty-three pairs of flame cells, assuming that this number is the result of a similar multiplication process, the flame cells of the cercaria may be calculated as being twenty-one pairs. Johnson described the cercaria of this parasite as possessing twenty-four pairs of flame cells, but, as already stated, he probably dealt with a different form of larva.

GENERAL SUMMARY

Snails (*Lymnaea peregra* Müller) obtained from an irrigation canal in Trinidad Valley, near Baguio, Mountain Province, Luzon, were found infested with two kinds of echinostome larvæ (trematodes) distinguishable from each other only by the number of spines on the head collars of the cercariæ and metacercariæ.

Encysted metacercariæ possessing thirty-seven cephalic spines, when fed to experimental animals, developed into adult worms in young house pigeons after twelve to fifteen days; they failed to infect rats and a monkey. The adult parasites have been identified as *Echinostoma revolutum* (Froelich, 1802).

Encysted metacercariæ with forty-five cephalic spines, when fed to experimental animals, developed into full-grown adults in white laboratory rats after ten to fifteen days; they failed to develop in young pigeons and in a monkey. The adult worms have been identified as *Euparyphium murinum* Tubangui, 1931.

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ILLUSTRATIONS

ABBREVIATIONS

ac, acetabulum.
bp, birth pore.
c, collar.
cc, cephalic collar.
cer, cercaria.
cp, cirrus pouch.
ct, caudal collecting tube.
eb, excretory bladder.
ep, excretory pore.
fc, flame cell.
ga, genital anlage.
gb, germ ball.
gp, genital pore.
int, intestinal cæcum.
la, locomotor appendage.
mt, main collecting tube.
œ, œsophagus.
ov, ovary.
ph, pharynx.
rg, rhabdocœle gut.
sg, shell gland.
t, testis.
ut, uterus.
vg, vitelline gland.

PLATE 1. EUPARYPHIUM MURINUM TUBANGUI, 1931

FIG. 1. Entire worm, ventral view, showing reproductive and digestive systems.
2. Outline of main excretory vessels and flame cells.

PLATE 2. STAGES OF EUPARYPHIUM MURINUM, EXCEPT FIG. 6

FIG. 1. Egg inclosing fully developed miracidium.
2. Young redia.
3. Mature redia inclosing cercariæ and germ balls.
4. Cercaria.
5. Encysted metacercaria.
6. Shells of *Lymnaea peregra* (Müller), ventral, lateral, and dorsal views.

PLATE 3. ECHINOSTOMA REVOLUTUM (FROELICH, 1802)

FIG. 1. Entire worm, ventral view, showing reproductive and digestive systems.
2. Outline of main excretory vessels and flame cells.

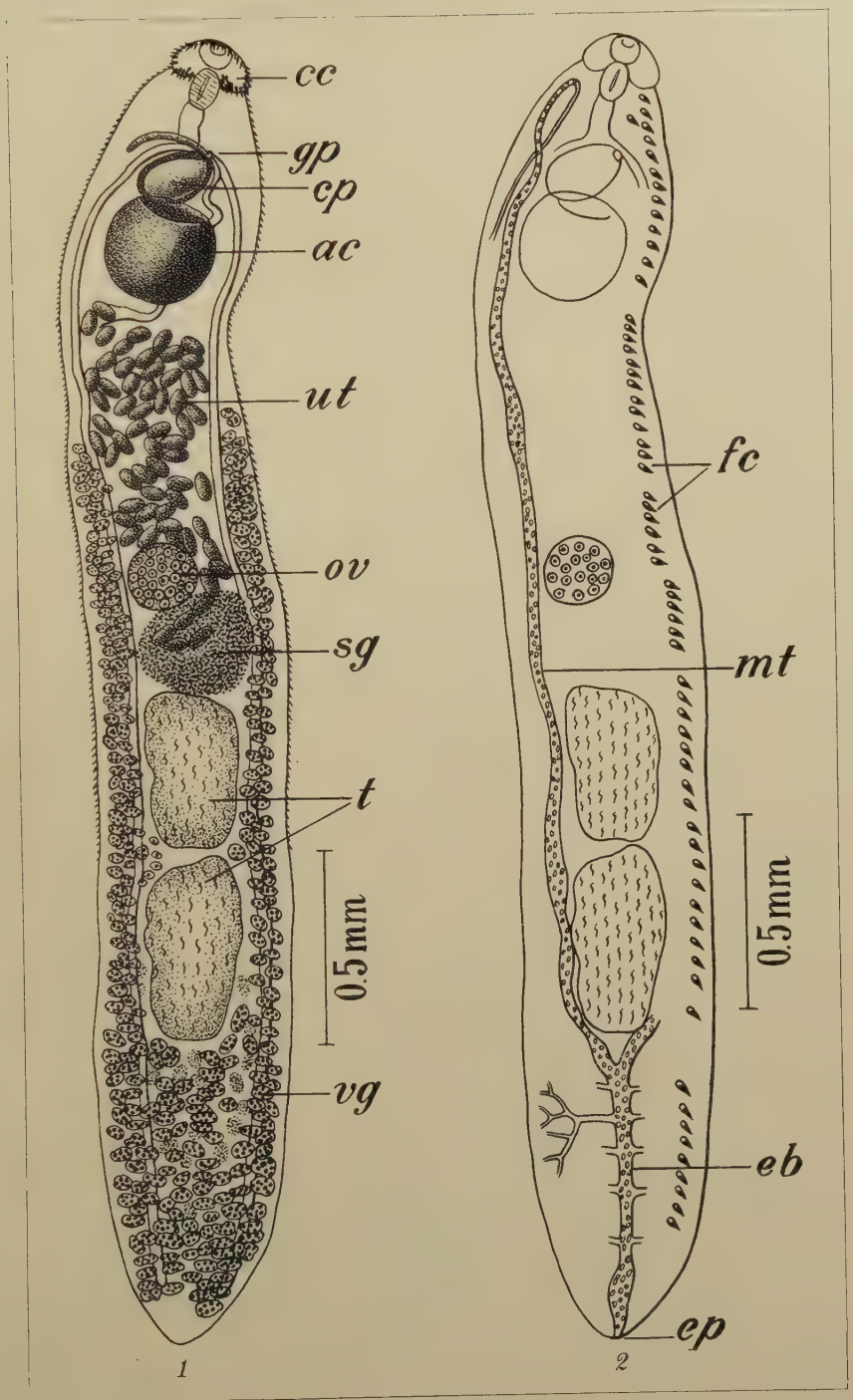

PLATE 1.

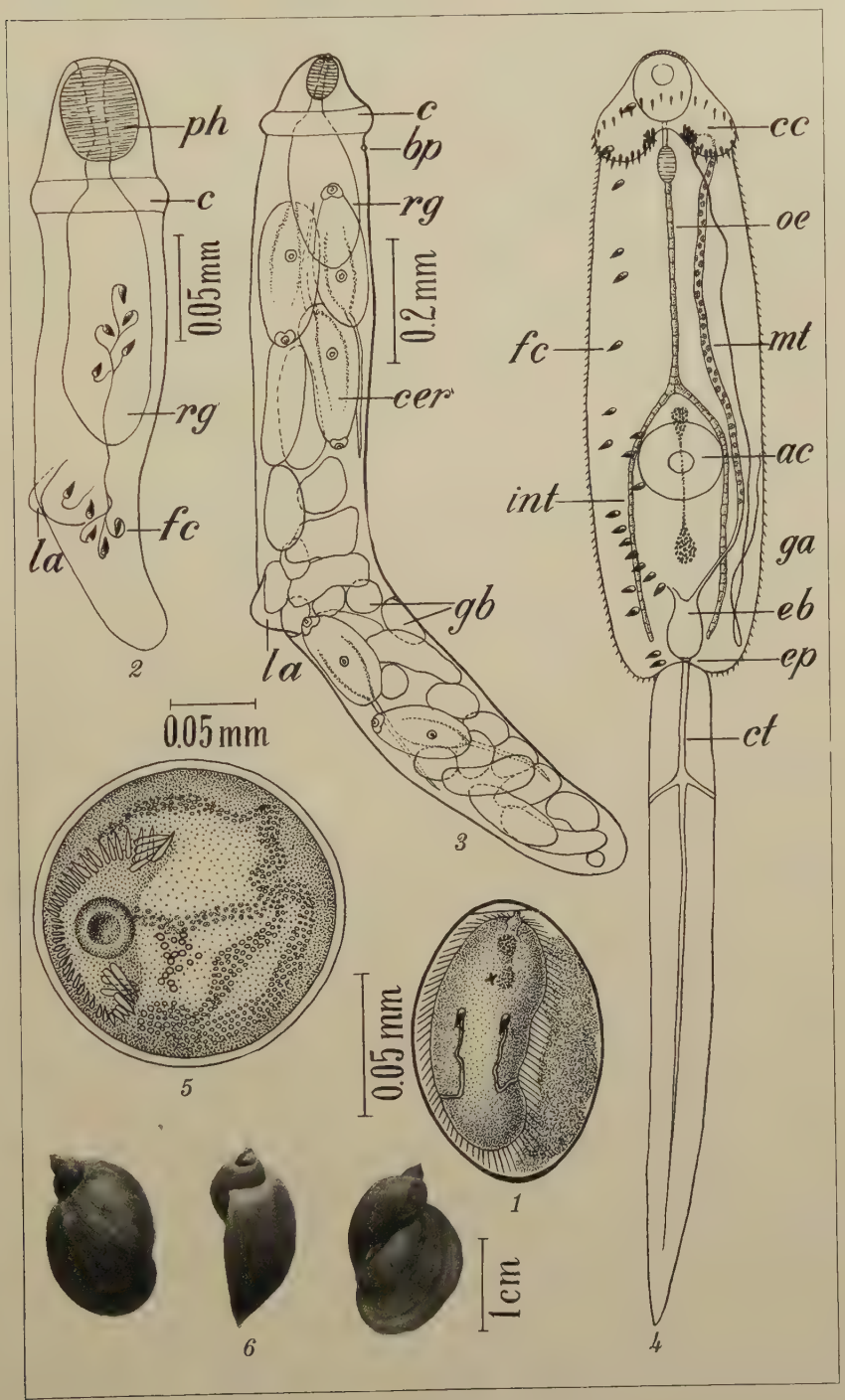
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PLATE 2.

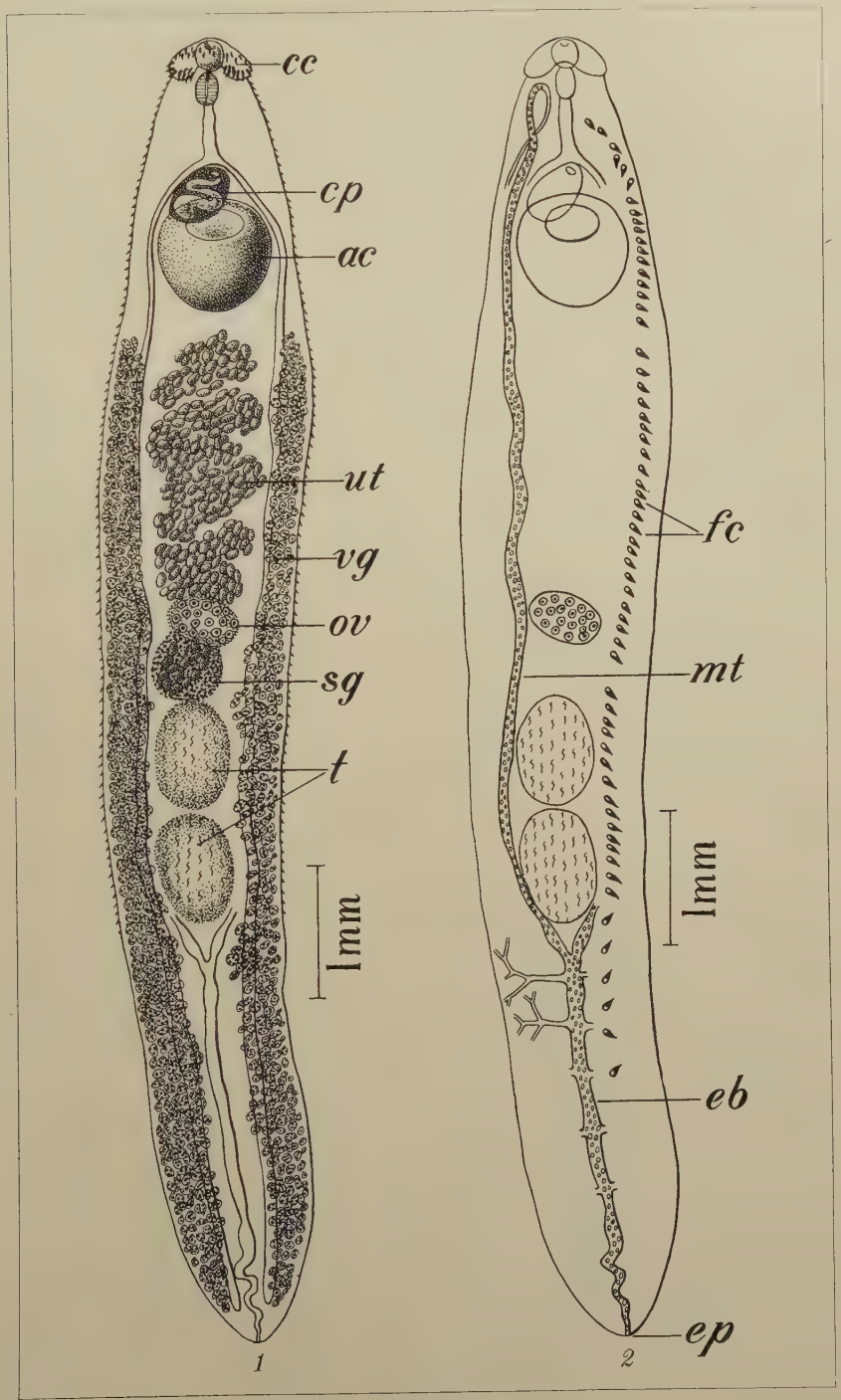


PLATE 3.

NEUE STAPHYLINIDEN (COLEOPTERA) DER PHILIPPINEN

3. BEITRAG ZUR KENNTNIS DER STAPHYLINIDEN

Von Alexander Bierig

Habana, Cuba

EINE TAFEL

Die nachfolgend als neu beschriebenen und abgebildeten Staphyliniden der Gattung *Eleusis* Castelnau befanden sich unter anderen in einer freundlichst für mich gemachten Aufsammlung des Entomologen Herrn Fred C. Hadden, Agricultural College, Laguna, Luzon, dem ich eine Art dankbar widme. Ich behalte mir vor, weitere, neue Arten aus genannter Familie und dem gleichen Faunengebiet spaterhin am selben Orte zu veröffentlichen.

Schon über dreizig Arten dieser Gattung sind vom Inselreich der Philippinen bekanntgemacht. Dass nun von sieben erbeuteten Arten fünf sich als neu erwiesen, spricht dafür, dass diese Gattung dort recht artenreich zu sein scheint, und sicher noch weitere Vertreter zu erwarten sind.

Den Beschreibungen sei Folgendes vorausgeschickt: Die gemachten Angaben über Massverhältnis der einzelnen Körperteile beziehen sich nicht auf (oft täuschendes) Augenmass, sondern auf wirkliche, möglichst genaue Messung, wie sie zur Herstellung der Habitusbilder nötig war. Relative Bemerkungen—ohne vergleichenden Masstab—wie zum Beispiel: "Fühler ziemlich lang" oder "ziemlich kurz," die in Neubeschreibungen regelmässig wiederkehren, suche ich zu vermeiden. Sie ermöglichen keine klare Vorstellung und können zu Täuschungen führen, wenn es sich um sehr ähnliche Tiere einer Sippe handelt, was recht oft der Fall ist. Und je mehr sich die Artenzahl einer Gattung vergrössert, desto wichtiger sind positive und fassliche Angaben der Grössenverhältnisse der verschiedenen Körperteile zueinander—wenn das Behandelte Bausteine sein sollen, anstatt "Hemmschuhe."

ELEUSIS AUGUSTÆ Bernhauer.

Eleusis augustæ BERNHAUER, Philip. Journ. Sci. 31 (1926) 247.

Die Körperlänge dieser Art, die mit 7.5 bis 8.5 mm fixiert ist, beträgt bei weiblichen Individuen oft nur 6.5 mm, bei normal gestrecktem Leib.

Hab. Mount Santo Tomas, 6,500 Fuss, 26. März 1931.

ELEUSIS BELUA sp. nov. Tafel 1, Fig. 1.

Der *E. angusticeps* Bernhauer [1] nahestehend. Von ihr durch doppelte Körperlänge, kürzere Fühler, mehr einheitlich dunkle Färbung, zwei Gruben auf der hinteren Halsschildpartie und so weiter verschieden.

Glänzend, bräunlichschwarz, Vorderrand des Kopfes, Mund, Fühler, Taster, Beine, Schultern und Hinterränder der Dorsalsegmente des Abdomens rotbraun. Grundskulptur sehr deutlich, kaum verworren, mit eingestreuten, tiefen Pünktchen, die auf dem Abdomen fehlen.

Lange 4.5 bis 5 mm.

Kopf gross, wenig länger als breit, parallelseitig mit runden Hinterecken; hinter dem Stirnhöcker (auf der Höhe des Augenvorderrandes) ist bei entsprechendem Lichteinfall oft jederseits eine flache Grube sichtbar; in der Mitte schmal gefurcht, die Furche hinten in einer breiten, rundlichen Depression vor dem Halse endend. Augen klein, Schläfen drei Mal grösser als der Augen Längsdurchmesser; die lange Furche über dem Auge reicht bis an die Rundung der Hinterecken und endet in einem borstentragenden Porenpunkt. Fühler nur ganz wenig länger als der Kopf (ohne die Mundwerkzeuge), Glied 3 wenig kürzer als 2, die vorletzten Glieder so lang wie breit.

Halsschild vorn wenig schmäler als der Kopf, wenig breiter als lang, am Vorderrand jederseits nahe den Ecken eine Gruppe von drei gleichweit entferntstehenden Pünktchen in einer Grube, Seiten Zähnchen scharf; eine sehr feine Mittellinie zieht nicht ganz bis zum Halse vor, in der hinteren Hälfte liegt jederseits eine breite, mässig tiefe Grube.

Flügeldecken etwas breiter als der Kopf, fast so lang wie breit, vorn wenig schmäler als hinten; der übliche Punkt auf jeder Decke ist sehr klein und kaum wahrnehmbar, und ein ebensolcher Punkt ist oft im vordern Viertel sichtbar.

[1] Philip. Journ. Sci. 31 (1926) 249.

Leib etwas schmäler als die Decken, hinten wenig breiter als vorn, die seitlichen Porenpunkte auf den Segmenten flach.

Die Grundskulptur verläuft am Kopf vorn in U-form, auf seiner Scheibe, longitudinal, ebenso längs der Mitte des Halsschildes und auf den Flügeldecken; auf dem Abdomen zieht sie wellig quer.

Beim ♀ verrunden die Schläfen in flachem Bogen zum Hals; der Kopf ist dadurch mehr eiförmig.

Sechs Exemplare wurden eingesammelt, die zum Teil in schlechtem Zustand sind.

Hab. Mount Data, 7,000 Fuss, 16. März 1931.

Type (♂), Para- und Cotypen in meiner Sammlung.

(Die Zeichnung ist nach der Type angefertigt.)

ELEUSIS HADDENI sp. nov. Tafel 1, Fig. 2.

Der Beschreibung nach dürfte diese Art mit *E. speculiceps* Bernhauer[2] verschiedene Berührungspunkte haben, wie zum Beispiel lange, schlanke Fühler und Halsschild ohne deutliches Seitenzähnchen. Die Verschiedenheit ist aber doch gross und liegt unter anderm in der sichtbaren Grundskulptur, mehr Körpergrösse und scheinbar dunkleren Flügeldecken.

Glänzend, pechschwarz, Mund und Beine hellrotbraun; Fühler von der Spitze des ersten Gliedes an bräunlichrot; Schenkel dunkler, hinterrand der Segmente rötlich durchscheinend, Verbindungshaut hellgelb (falls sichtbar). Flügeldecken bräunlichgelb; Naht, Seiten- und Hinterrand dunkel. Grundskulptur sehr fein und flach mit wenigen, zarten, eingestreuten Pünktchen, auf dem Leib fast erloschen.

Länge 5.5 mm, bei etwas ausgezogenem Hinterleib.

Kopf rundlich viereckig, etwas breiter als lang, mit vorgewölbten, mit dem Hals verrundeten Schläfen, die zwei Mal so lang sind, wie der Augen Längsdurchmesser. Fühlerbeulen breit, Furche über dem Auge doppelt so lang wie dieses. Linke Mandibel mit deutlichem Innenzahn versehen, Fühler so lang wie der Kopf (ohne den Mund) und Halsschild, alle Glieder ziemlich länger als breit.

Halsschild so breit wie der Kopf, ohne seitliche Einkerbung, an Stelle des üblichen Zähnchens auf einer kleinen Unebenheit nur ein borstentragender Porenpunkt, innerhalb der Vorderecken

[2] Philip. Journ. Sci. 31 (1926) 250.

in einer Grube zwei Punkte, längs der Mitte fein gefurcht, Furche weder den Vorder- noch den Hinterrand berührend, Scheibe leicht niedergedrückt.

Flügeldecken wenig breiter als der Kopf, so lang wie hinten breit, vorn wenig schmäler und mit geraden Seiten, der Punkt auf jeder Decke deutlich.

Abdomen nicht ganz so breit wie die Flügeldecken, von der Mitte an verjüngt, die seitlichen Punkte ziemlich scharf.

Die Grundskulptur verläuft am Kopf über der Stifnbeule wagerecht, über den Augen) (-förmig, vor dem Hals Ωförmig; in der Halsschildmitte dachformig (doch fast rechtwinkelig zur Mittellinie); auf dem ersten Flügeldeckendrittel von der Schulter zur Mitte der Naht, dann mehr in Längsrichtung; am Abdomen wellig quer.

Ein Exemplar als Type in meiner Sammlung, scheinbar ein ♂.

Hab. Mount Maquiling, 400 Fuss, Laguna.

ELEUSIS PALAWANENSIS Bernhauer.

Eleusis palawanensis BERNHAUER, Philip. Journ. Sci. 31 (1926) 249.

Ein Exemplar vom Mount Maquiling deckt sich mit der kurzen Beschreibung dieser Art. Leider ist nichts über das charakteristische Seitenzähnchen des Halsschildes gesagt, das bei meinem Individuum recht klein aber deutlich ist.

ELEUSIS DERIVATA sp. nov. Tafel 1, fig. 3.

Der grossen Augen wegen scheint diese Art der *E. crassicornis* Bernhauer [3] nahe zu stehen. Wahrscheinlich sind die Augen sogar grösser, die Fühler im Gegensatz lang, der Käfer ist grösser und dunkler gefärbt.

Sehr glänzend, rötlichbraun, der Kopf, die hinteren zwei Drittel der Flügeldecken und das vorletzte Dorsalsegment schwärzlich, Mund, Fühler, Schulterpartie der Flügeldecken, Beine und die hintere Hälfte der Segmente eine bis einschliesslich vier hell rötlichgelb, der Hinterrand des 5. und des 6. (letzte) Segment rötlich. Grundskulptur sehr zart und fein, am Abdomen bein 35 maliger Lupenvergrösserung gerade noch bemerkbar, die eingestreuten Pünktchen—am Vorderkörper—deutlich.

Länge 3 bis 4 mm.

Kopf quer rundlich, etwas kürzer als breit, breiter als der Halsschild, an der Fühlerwurzel breiter als an den Schläfen, vor dem Hinterrand der Quere nach leicht eingedrückt; Augen

[3] Philip. Journ. Sci. 31 (1926) 250.

gross und vorquellend, Schläfen sehr klein kürzer als der daran anschliessende, dicke, konische Hals. Fühler so lang wie Kopf (einschliessend dem Mund) und Halsschild, die vorletzten Glieder wenig länger als breit.

Halsschild ein Viertel breiter als lang, Seiten erst eine kurze Strecke gerade, dann sanft verrundet, Seitenzähnchen hinter einer sehr schwachen Kerbe leicht angedeutet, innerhalb der Vorderecken erscheint im richtigen Licht neben einer Unebenheit ein kleiner Punkt, Scheibe abgeplattet.

Flügeldecken an den Schultern so breit wie der Kopf und fast rechtwinkelig, nur wenig länger als breit, der Punkt auf jeder Decke scharf eingestochen.

Leib bis zum vorletzten Segment parallel und etwas weniger breit als die Flügeldecken. Borstenpunkte längs der Seiten deutlich.

Die feine Grundskulptur des Kopfes verläuft auf dem Stirnhöcker quer, seitlich) (-förmig, hinter dem hinteren Eindruck quer; die der Halsschildmitte läuft spitz dachgiebelförmig; auf den Decken zieht sie fast longitudinal, am Abdomen unklar und verworren quer.

Beim ♀ scheint der ganze Vorderkörper geringer zu sein.

Eine Anzahl Individuen vom genannten Orte.

Hab. Mount Santo Tomas, 6,500 Fuss, 26. März 1931.

Type (♂) und Paratypen in meiner Sammlung, Cotypen in der Haddenschen und meiner eigenen.

(Die Zeichnung ist nach den Massverhältnissen der Type hergestellt.)

ELEUSIS SEMISPLENDIDA sp. nov. Tafel 1, fig. 4.

Von habitueller Ähnlichkeit mit der *E. derivata* m. Doch sind die Augen kleiner, die Zähnchen seitlich am Halsschild deutlich, das ganze Tier grösser, am Vorderkörper scharf nadelrissig skulptiert, und das letzte Dorsalsegment ist schwarz.

Glänzend schwarz; Mund, Fühler, Beine, erste Drittel der Flügeldecken und das hintere Drittel der Abdominalsegmente (oben) hell bräunlichrot, die Schenkel angedunkelt. Die in die Grundskulptur eingestreuten Pünktchen sind deutlich und ziemlich regelmässig aufgeteilt; sie sind am Abdomen kaum bemerklich.

Länge 5 mm, bei wenig ausgezogenem Leib.

Kopf rundlich viereckig, so lang wie breit, an der Fühlerwurzel etwas enger als an den Schläfen, Augen mässig gross, von oben besehen so gross wie die Schläfen, Hinterecken stumpf

gerundet, Hals dick und wie bei der vorherigen und der folgenden Art als Konus aus dem Halsschild ragend, über dem Hals in einer rundlichen und flachen Erhabenheit eine seichte Einsenkung. Mundwerkzeuge auffallend klein, Fühler so lang wie Kopf (ohne Mund) und Halsschild, alle Glieder länger als breit.

Halsschild wenig schmäler als der Kopf, kaum etwas breiter als lang, erst ein gutes Stück parallelseitig, dann bis zu dem scharf vorspringenden Zähnchen eingebogen, von da mit dem Hinterrand verrundet. Scheibe platt und leicht eingedrückt, hinten mit glatter, schmaler Längszone (wie ein abgeschliffener Kiel). Dicht neben einem deutlichen, stumpfen Zähnchen innerhalb der Vorderecken sitzen zwei Porenpunkte, von denen der äussere der grössere ist.

Flügeldecken an den Schultern so breit wie der Kopf am Augendurchmesser, im zweiten Drittel nach sanfter Auswärtsrundung etwas breiter, so lang wie breit, der eingestochene Punkt wenig tief aber deutlich.

Leib nicht ganz so breit wie die Flügeldecken und fast ganz gleichbreit, etwas flacher, als es bei andern Arten der Fall zu sein pflegt; seitliche Porenpunkte sehr leicht.

Die Grundskulptur ist in der Mitte des Kopfes verworren längsgerichtet, ganz vorn quer; am Halsschild und den Flügeldecken der Längenachse folgend, nicht ganz so sehr verworren und weniger scharf; auf den Leibesringen befindet sich eine lederartig schuppige Körnelung, wodurch sie matten Glanz erhalten.

Ein einziges Exemplar als Type in meiner Sammlung; das Geschlecht lässt sich nicht mit Sicherheit feststellen.

Hab. Mount Santo Tomas, 6,500 Fuss, 26. März 1931.

ELEUSIS MULTIZONATA sp. nov. Tafel 1, Fig. 5.

Diese niedliche Art ist sehr auffallend durch die vom 4. Glied an schwarzen, lose gegliederten Fühler mit hellgelben Verbindungsstielchen. Das Abdomen ist aussergewöhnlich breit.

Sehr glänzend, rötlichgelb; Kopf und die letzten sieben Fühlerglieder schwarz, die hinteren drei Fünftel der Flügeldecken, die vorderen zwei Drittel der Sternite (das letzte gänzlich) braun, die Verbindungshaut der Sternite weiss. Die feine Grundskulptur ist bei 35 maligern Lupenvergrösserung noch wahrnehmbar, und spährlich eingestreute Punkte treten deutlich hervor.

Länge 2.5 mm, bei ausgezogenem Leib.

Kopf rundlich, mit den Augen wenig breiter als ohne den Mund lang, an den Fühlerwurzeln nicht so breit wie an den Schlafen, diese ungefähr so lang wie Augen; plattgedrückt, hinten etwas erhaben über den Hals gezogen (ähnlich wie bei *E. semisplendida* m.), Hals breit, konisch und verragend; Fühler so lang wie Kopf und Halsschild, die vorletzten Glieder wenig quer.

Halsschild fast um ein Drittel breiter als lang, seitlich in einem Zug gerundet und mit kaum merklicher Einkerbung an der Stelle des sonst üblichen Zähnchens, Scheibe wenig eingedrückt. Innerhalb der Vorderecken kein Eindruck und nur ein kleiner Porenpunkt daselbst.

Flügeldecken fast parallelseitig, so breit wie der Kopf, ein Fünftel länger als breit, der eingestochene Punkt ausserst klein.

Abdomen von der Basis bis zum 3. Segment so breit wie die Flügeldecken (oder wenig breiter), seitliche Porenpunkte sichtbar.

Der Verlauf der kaum sichtbaren Grundskulptur dürfte bei dieser sonst so auffallenden Art von nur untergeordneter Bedeutung sein.

Drei Exemplare wurden eingesammelt, wovon zwei unreif, beim Trocknen eingesunken und auch sonst in schlechtem Zustand sind; sie befinden sich in meiner Sammlung.

Hab. Mount Santo Tomas, 6,500 Fuss, 26. März 1931.

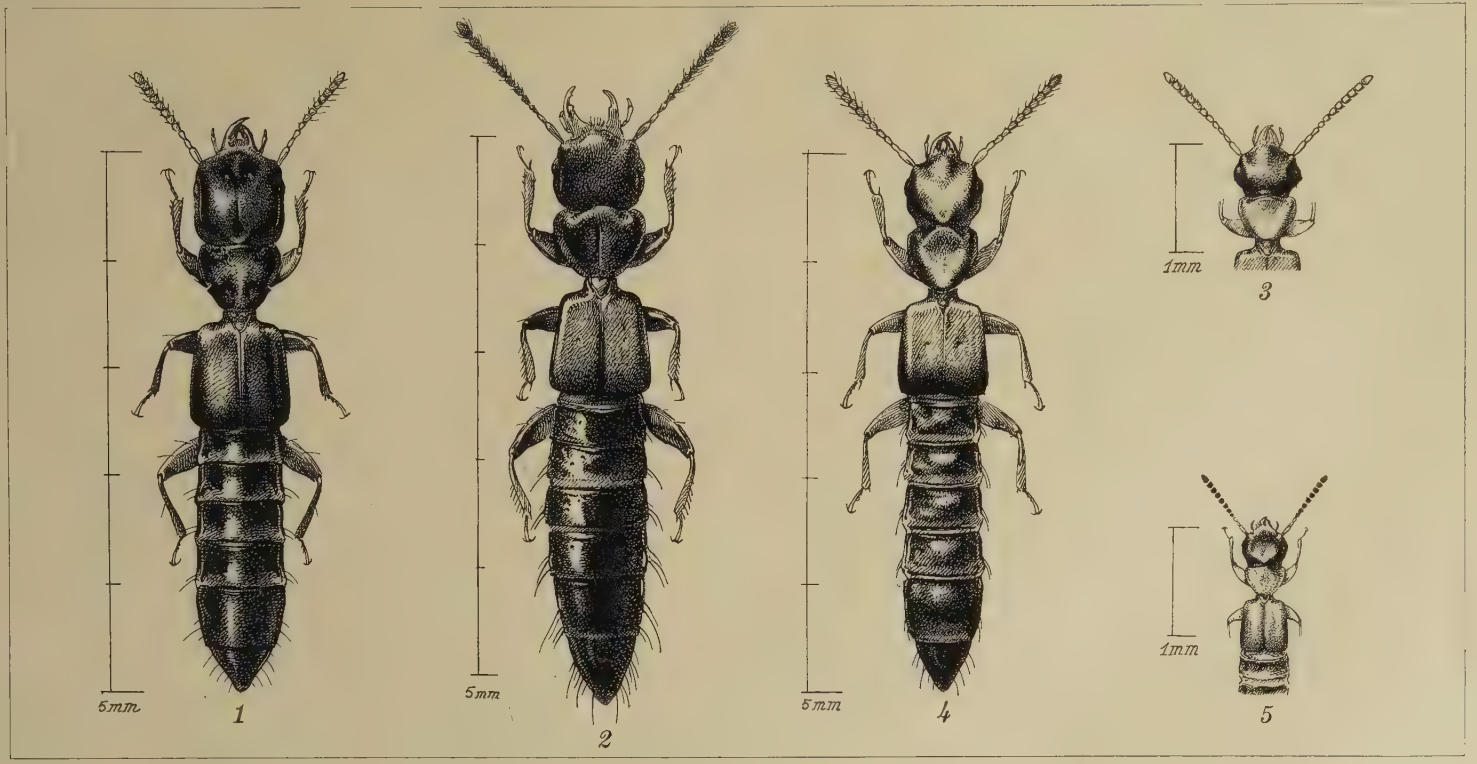
Type, ♂ (?); nach ihr ist die Zeichnung gemacht.

266903——7

ABBILDUNGEN

Tafel 1

Fig. 1. *Eleusis belua* sp. nov., ♂.
2. *Eleusis haddeni* sp. nov., ♂?
3. *Eleusis derivata* sp. nov., ♂.
4. *Eleusis semisplendida* sp. nov.
5. *Eleusis multizonata* sp. nov.



TAFEL 1.

RUBBER CONTENT OF PHILIPPINE PLANTS, I: FICUS

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and

Pacita Cabato

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Due to the ever-increasing demand for rubber in the world's market, the search for rubber-producing plants is a problem of considerable interest. This is particularly true in countries where owing to climatic conditions and soil characteristics the question of finding a satisfactory substitute for the heveas, the plants that furnish the greatest bulk of natural rubber consumed by the industries of the world, has been the subject of speculation and research.

The investigations have produced significant results, since various plants are now known that can be utilized as commercial sources of the raw material and great possibilities are believed to exist in some of these. Thus, according to a recent report,[1] the late Thomas Alva Edison, the famous electrical wizard, had succeeded in growing a 12-foot rubber-yielding goldenrod (*Solidago*) after raising and cross-breeding thousands of plants within the last few years in his experimental station at Fort Myers, Florida. The guayule plant (*Parthenium argentatum* A. Gray), which grows wild on the deserts of the Mexican and the American border and which in 1904 rose to a price of 75 dollars per ton incident to the industrial exploitation of the plant for rubber in Mexico,[2] is now extensively cultivated at Salinas, California, and in some parts of the western United States. According to Hall and Goodspeed,[3] who made a rubber-plant survey of western North America, it seems probable that not less than 300,000,000 pounds of chrysil, a new rubber from *Chrysothamnus nauseosus*, can be produced from this shrub in

[1] Pop. Sci. Month. 118 No. 4 (April, 1931) 32.

[2] Standley, P. C., Contr. U. S. Nat. Herb. 23 pt. 4 (1924) 1520.

[3] Univ. Calif. Publ. Bot. 7 (1919) 210.

all of the Western States. These possibilities are significant, particularly to the United States where the industrial requirement is about 80,000,000 pounds of rubber per month.[4] The Ceara caoutchouc tree (*Manihot glaziovii* Muell.-Arg.) a South American species, which is now acclimatized in Congo, Ceylon, German East Africa, and the Philippines; the castilloas of Central America; the kickxias of the African west coast; and some of the milkweeds are other plants promising rubber production in commercial quantities.[5]

In the Philippines, the three rubber plants that are being cultivated on a commercial scale are the Para (*Hevea brasiliensis* Muell.-Arg.), the Ceara (*Manihot glaziovii* Muell.-Arg.), and the castilloa (*Castilloa elastica* Cerv.). Due to the fertile soil and the warm climate these plants thrive well in various regions of the Archipelago, especially in the southern part outside of the typhoon belt. Also under these favorable tropical conditions there are various latex-producing plants growing abundantly everywhere.

However, very little is known as to their industrial possibilities; it is, therefore, interesting to know which of them contain rubber. With this aim in view investigation was begun. The fact that there are several species of *Ficus* widely distributed in the Islands at once suggested that it would be advisable to begin the study with this genus. Furthermore, as can be seen from Table 1, many species of *Ficus* containing rubber are already known in other countries; obviously, it would be of interest to compare the extent of the occurrence of rubber in Philippine *Ficus* plants with that in the foreign ones.

In searching for previous work on rubber, as reported in the Philippines, but few references directly relating to the chemical aspect of the problem were found. However, there are some interesting papers dealing with phases presented by the cultivation of rubber plants. For instance, Worcester [6] has discussed at length the cultivation, propagation, and tapping of Ceara and Para rubber plants in the southern Philippine Islands. In this article, the land laws and the estimates of expense and profit in connection with the cultivation of rubber plants are also given. Aldaba [7] has made an interesting botanical study of the culti-

[4] Scientific Monthly (November, 1928) 413.

[5] Clouth, F., Rubber, Gutta-percha and Balata. First English translation (1903) 30–55.

[6] Far Eastern Rev. 9 No. 2 (1912) 131.

[7] Philip. Agr. 7 (1919) 274.

vation and tapping of castilloa rubber in the Philippines, where environmental and soil conditions, methods of culture, clearing, pests, diseases affecting the plant, tapping, and improvement by selection are among the many points discussed.

Manas [8] and Elayda [9] have tested the germination of the seeds of rubber plants that were mostly of foreign origin. Among the plants tested were *Manihot dichotoma* Ule, *M. piacuyensis* Ule, *M. heptaphylla* Ule, *Marsdenia verrucosa* Decne, *Mimusops balata* Blume, *Cryptostegia madagascariensis* Boj., and *Marsdenia verrucosa* Decne.

In his anatomical study of the laticiferous vessels in *Hevea brasiliensis*, Quisumbing [10] states that these vessels occur in the pith in young stems and in seedlings and also in the leaves and roots. He further observes that the latex tubes originate from the cambium in the secondary cortex, within the stone ring; or from the primary cortex and phellogen, outside of the stone ring.

Of further interest to the public and in particular to rubber planters in the Philippines are the works of Sarmiento,[11] Hester,[12] Muzzal, [13] Mendiola,[14] and Tamesis.[15] In these papers, important problems relative to the cultivation of rubber in the Islands are presented. Besides these publications, there are the monthly bulletins of the Bureau of Commerce and Industry and the annual reports of the Bureaus of Agriculture and Forestry of the Philippine Government, which are among the best sources of information on the progress of rubber planting in the Islands.

So far as known, the Philippine latex plants that have been chemically examined for rubber or gutta-percha are the "tagulaoay" (*Parameria philippinensis*, Radlk.), "dita" [*Alstonia scholaris* (Linn.) R. Br.], "palakpalak" [*Palaquium philippense* (Perr.) C. B. Rob.], and *Micrechites schrieckii* (Van Huerck and Muell.-Arg.) Rolfe. In the first plant, Bacon [16] found that the bark contains 4 to 5 per cent of rubberlike gum, but he believes that the commercial utilization of this rubber vine is very doubt-

[8] Philip. Agr. & For. 1 (1911) 118.
[9] Philip. Agr. & For. 2 (1912) 28.
[10] Univ. Calif. Pub. Bot. 13 (1927) 319.
[11] Philip. Agr. 5 (1916) 159.
[12] Philip. Agr. 12 (1923) 43.
[13] Makiling Echo 3 No. 4 (1924) 9; 4 No. 4 (1925) 2.
[14] A Manual of Plant Breeding for the Tropics. Chapter XI. Bureau of Printing, Manila (1926).
[15] Makiling Echo 5 No. 1 (1926) 18; No. 2, 13.
[16] Philip. Journ. Sci. § A 4 (1909) 166.

TABLE 1.—*Foreign species of Ficus reported to contain rubber.*[a]

Species.	Local name.	Where found.			
		America.	Africa.	Asia.	Australia.
Ficus altissima Blume				Sumatra, Java	Australia.
Ficus annulata Blume				Pegu, Siam, Malacca	
Ficus crassinervia Desf		Guadeloupe			
Ficus elastica Roxb	Karet, karet-tapok, pohon-karet, kohlet.			Bengal, Prince of Wales' Islands, Malacca, Cochin-China, Annam, Tonkin, Java.	
Ficus glomerata Roxb				British India	
Ficus holstii Warb	Msoso		German East Africa		
Ficus incisa Wall	Banian				New Caledonia.
Ficus indica Linn	Cashmir, banjan			Bengal, Assam, Burma, Singapore, Siam, Malacca, Philippines.	
Ficus laccifera Roxb	Hyoung-pen			Assam, Pegu, Siam	
Ficus lentiginosa Vahl		Guadeloupe			
Ficus macrophylla Roxb				Java, Sumatra, Indian Archipelago.	Australia.
Ficus medina Kahl			Senegambia, Soudan.		
Ficus obtusifolia Roxb	Hyoung-hyap			Chittagong, Siam, Malacca	
Ficus oppositifolia Willd				British India	
Ficus pertusa Linn		Guadeloupe			
Ficus prinoides Humb. and Bonpl	Banut-kalodja				
Ficus racemosa Wall			South of the Ivory coast.		
Ficus radula Willd		Venezuela			
Ficus religiosa Linn				Bengal, Java	

Ficus rubiginosa Desf			Java, Sumatra, Indian Archipelago.	Australia.
Ficus subcalcarata Warb				
Ficus tammako	N'daba touronim koko, n'zéne touron.		Senegambia, Soudan.	
Ficus trichopoda Baker			Madagascar.	
Ficus usambarensis Warb			German East Africa.	
Ficus vogelii Miq	Aba.		Gold Coast.	

[a] Clouth, Franz, Rubber, Gutta-Percha and Balata, first English translation (1903) 16–20.

TABLE 2.—*Chemical analyses of stems and leaves of Ficus.*

[Based on moisture-free samples.]

Species.	Local name.	Place of collection.	Part used.	Acetone extract.	Benzene extract.
				Per cent.	*Per cent.*
Ficus ampelos Burm	Malaisís	Makiling Botanic Garden, Laguna	Leaves	8.20	0.02
			Bark of stem	3.26	0.11
Ficus balete Merr	Baléte-pulá	do	Leaves	13.04	0.06
			Bark of stem	6.83	0.09
Ficus barnesii Merr	Tibig, tagkulabas	do	Leaves	6.11	0.01
			Bark of stem	4.37	0.07
Ficus calophylloides Elm	Baléte, tibi	Manila	Leaves	7.79	0.08
			Bark of stem	19.71	0.73
Ficus cassidyana Elm	Tambon, tubog	Makiling Botanic Garden	Leaves	7.83	0.01
			Bark of stem	3.43	0.08
Ficus celebica Blume	Takines, maladaliket	do	Leaves		
			Bark of stem	2.58	0.06
Ficus conora King	Basikong	do	Leaves	14.25	0.07
			Bark of stem	6.51	0.05
Ficus cuernosensis Elm	Tabúgai, tabog	do	Leaves	19.29	0.04
			Bark of stem	6.63	0.06
Ficus elastica Roxb		do	Leaves	11.20	0.11
			Bark of stem	12.46	3.56
Ficus hauili Blanco	Hauíli, lagmut	Manila	Leaves	6.48	0.08
			Bark of stem	4.71	0.07
Ficus irisana Elm	Pilí-na-dakó	Makiling Botanic Garden Laguna	Leaves	8.38	0.07
			Bark of stem	1.68	0.06
Ficus malunuensis Warb	Bugarila, kalukoi	do	Leaves	9.81	0.06
			Bark of stem	1.50	0.05
Ficus manilensis Warb	Uplás, butlí	do	Leaves	5.66	0.09
			Bark of stem	3.85	0.08

Ficus minahassae (Teysm. and De Vr.) Miq	Hagúmit	Manila	Leaves	8.18	0.02
			Bark of stem	5.09	0.52
Ficus nervosa Heyne	Kanápai, tagitig	Makiling Botanic Garden	Leaves	23.44	0.03
			Bark of stem	2.71	0.10
Ficus nota (Blanco) Merr	Tebel, tuyokai	Manila	Leaves	11.10	0.02
			Bark of stem	14.27	0.02
Ficus odorata (Blanco) Merr	Agosos	Makiling Botanic Garden, Laguna	Leaves	11.79	0.03
			Bark of stem	2.95	0.10
Ficus payapa Blanco	Payápa	Manila	Leaves	12.87	0.02
			Bark of stem	3.54	0.06
Ficus philippinensis Miq	Diákit, tayabas	do	Leaves	4.99	0.08
			Bark of stem	12.63	0.10
Ficus pisifera Wall	Isís ligau, pilig	Makiling Botanic Garden, Laguna	Leaves	11.57	0.02
			Bark of stem	2.19	0.07
Ficus pseudopalma Blanco	Niog-niog, lubi-lubi	do	Leaves	9.97	0.06
			Bark of stem	2.28	0.05
Ficus pubinervis Blume	Deudéu, duugo	do	Leaves	15.7[illegible]	0.07
			Bark of stem	2.45	0.10
Ficus ulmifolia Lam	Isís, hagupít	Manila	Leaves	8.57	0.03
			Bark of stem	2.32	0.10
Ficus variegata Blume	Laptái, tabgón, tubol	Makiling Botanic Garden, Laguna	Leaves	5.95	0.02
			Bark of stem	6.79	0.07

ful. In the case of the other plants, analyses made by the American Chicle Company [17] show that they contain gutta percha, although it is doubted whether the gum can be of much value in the chewing-gum industry.

In this report, twenty-four species of *Ficus* were examined.[18] Thirteen of these are endemic and the rest are either introduced species or Pantropic in cultivation. The species that were found to contain rubber are *Ficus minahassae* (Teysm. and De Vr.) Miq., *F. elastica* Roxb., and *F. calophylloides* Elm. The rubber extracted from the above-mentioned species was found to agree closely in its percentage composition with the hydrocarbon of the formula $C_{10}H_{16}$ which is the greatly preponderating constituent of Para rubber.

EXPERIMENTAL

The material consisted of stems and leaves of *Ficus* which were obtained from the neighborhood of Manila and from the Makiling Botanic Garden,[19] Agricultural College, Laguna. The leaves and the bark of the stems were air-dried and ground to pass through a 20-mesh sieve. Moisture determinations of the different powdered samples were made and the results of the analyses expressed in terms of the moisture-free basis.

For the determination of rubber in the samples, the method recommended by Hall and Goodspeed [20] was adopted. The acetone extraction, however, was prolonged for more than three hours since it was found that the coloring matter could not be removed in this period of extraction as prescribed in the original method.

From Table 2, it can be seen that the major portion of the gummy constituent of the latex is removed by the acetone extract which represents approximately all the resins, fats, and coloring substances. In the benzene extract which contains rubber, only three species of *Ficus* were found to give an appreciable residue. These are *F. calophylloides* Elm., *F. elastica* Roxb., and *F. minahassae* (Teysm. and De Vr.) Miq. The per cent of rubber in

[17] Makiling Echo 9 No. 4 (1930) 38.

[18] The writers are deeply appreciative of the help rendered by Dr. E. Quisumbing, of the Bureau of Science, in the identification of these species.

[19] The writers wish to express their thanks to Prof. Carlos Sulit and Mr. Mamerto Sulit, of the School of Forestry, University of the Philippines, for their kindness in supplying some of the samples used in this investigation.

[20] Univ. Calif. Pub. Bot. 7 (1919) 216.

the bark of the stem of these plants is 0.73, 3.56, and 0.52, respectively. The amount of rubber thus obtained, however, is subject to fluctuation as there are several factors, such as the age of the plant, soil and climatic conditions, which must necessarily affect the yield of rubber in a given plant. While the other samples analyzed show that there is a small amount of benzene extract, this may be due to the resinous matter which was not completely removed by acetone. Moreover, the amount of the extract is such that the presence of rubber in them is doubtful.

From the elementary composition [21] of the rubber obtained from the above-mentioned plants, as shown in Table 3, the percentage composition of the hydrocarbon agrees very closely with that reported for Para and India rubber.

TABLE 3.—*Ultimate analysis of rubber from Philippine Ficus.*

Species.	Carbon.	Hydrogen.	Oxygen 100—(C+H).	Carbon : Hydrogen.
	Per cent.	*Per cent.*	*Per cent.*	
Ficus minahassae	87.16	11.85	0.99	10 : 16.18
Ficus elastica	86.40	12.00	1.60	10 : 16.52
Ficus calophylloides	85.70	11.92	2.38	10 : 16.41

SUMMARY

Chemical analyses of twenty-four species of Philippine *Ficus* for the rubber content was performed. These species were collected from the vicinity of Manila and from the Makiling Botanic Garden, Agricultural College, Laguna.

The species which were found to contain rubber are *F. calophylloides* Elm., *F. elastica* Roxb., and *F. minahassae* (Teysm. and De Vr.) Miq. The percentages of rubber found in the stems of these plants are 0.73, 3.55, and 0.52 respectively.

From the elementary analysis, the rubber obtained from the above-mentioned species contains the hydrocarbon of the formula $C_{10}H_{16}$ which is the prevailing constituent of Para rubber.

[21] The writers are indebted to Dr. Alfredo Santos, School of Pharmacy, University of the Philippines, for the microelementary analysis of the rubber samples.

STUDIES AND ILLUSTRATIONS IN THE POLYPORACEÆ, II

FOMES PACHYPHLOEUS PATOUILLARD AND FOMES MAGNOSPORUS LLOYD [1]

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TEN PLATES

Fomes pachyphloeus is quite common in the Philippines and is so distinctive in structure that it can easily be separated from all other members of the genus. Its closest relative is *Fomes magnosporus* Lloyd,(15) from which it differs structurally in the distribution and abundance of the characteristic seta-like hyphæ in the context, the presence of small setæ in the pores, and the smaller spores. It is of wide distribution in the Tropics. Bresadola(4) reports it from Suriman, South America. In Africa it is recorded by Bresadola(2, 4) and Patouillard(20) from the Kamerun, by Wakefield(28) from Nigeria, by Deighton(7) from Sierra Leone, by Patouillard and Hariot(25) from Senegal, and by Lloyd(17) without giving locality. It is also reported from Madagascar(14) and Mauritius(13) by Lloyd. It was originally described from Fiji(20) by Patouillard. Parks(19) finds it in Tahiti. Both Bresadola(3) and Lloyd(12) report it from Java. In Indo-China Patouillard lists it from Annam,(24) from Cambodia,(22) and from Tonkin.(23) Two specimens have also been received from the Federated Malay States. From the Philippine Islands it is recorded by Bresadola,(4, 5) by Graff,(9) by Lloyd,(16) and by Reinking.(27)

[1] The first paper of this series is one by the same authors entitled, "A partial revision of the Ganoderma applanatum group, with particular reference to its Oriental variants," Philip. Journ. Sci. 45 (1931) 483–589.

HOSTS AND ECONOMIC IMPORTANCE

It is a vigorous wood-destroyer found frequently on dead standing trees and fallen trunks in the forest and occasionally producing extensive heart rot in mature or overmature living trees, having a preference in the Philippines for the more perishable species. Ten hosts have so far been identified in the Philippines; namely, *Albizzia procera* (Roxb.) Benth., *Ficus* sp. [Reinking(27)] *Hopea acuminata* Merr., *H. philippinensis* Dyer, *Parashorea malaanonan* (Blco.) Merr., *Parkia javanica* (Lam.) Merr., *Pentacme contorta* (Vid.) Merr., *P. mindanensis* Foxw., *Rhizophora candelaria* DC., *R. mucronata* Lam., *Shorea guiso* (Blco.) Blm., and *Shorea* sp.

In addition to these records Deighton(7) and Patouillard and Hariot(25) report it on *Parinarium excelsum* in West Africa, Parks(19) on an old mango in Tahiti, and Faris(8) reports a *Fomes*, perhaps *F. pachyphloeus*, as a possible cause of the "zonate foot rot" of sugar cane in Cuba.

TAXONOMY AND SYNONYMS

The fungus was originally described in August, 1899, by Patouillard(20) from Fiji, as *Polyporus pachyphloeus*, with the citation also of a specimen from Kamerun which Bresadola redescribed the following year and of which he gave a colored illustration. In 1900, Patouillard(21) transferred it to Quélet's genus *Phellinus* erected four years earlier(26) on the following characters: "Pileus velutinus, persistens. Caro suberosa. Pori parvi, fulvo-brunnei. Spora ovoidea, fulva. Lignatiles." This genus has been used, mostly by French mycologists, for certain species formerly placed in *Fomes*, *Polyporus*, and *Poria*. In fact, the genus *Fomes* was not recognized at all in Quélet's Enchiridion or Patouillard's Essai Taxonomique and does not find a place even in the most modern work on French fungi by Bourdot and Galzin.(1)

In 1917, Murrill(18, p. 476) described his *Elfvingia elmeri* from specimens collected by *A. D. E. Elmer* (*6961*) on dead wood, Mount Mariveles, Bataan Province, Luzon, Philippine Islands (Plate 3, figs. 5 and 6; Plate 5, fig. 4; Plate 7, fig. 7). The cotype of this in the Elmer herbarium is certainly not distinct from *Fomes pachyphloeus*, of which there are available for comparison two specimens from Indo-China and the Philippines determined by Patouillard. Bresadola(4) reported the two species as synonymous in 1912.

In the Bureau of Science there is a packet bearing the following data "*Pyropolyporus Merrillii* Murr. n. sp., on prostrate log, Island of Culion, *3575, E. D. Merrill,* Dec., 1902." This is indorsed "Cotype" but contains only a small specimen of typical *Fomes pachyphloeus* (Plate 3, figs. 7 and 8; Plate 5, fig. 6).

Murrill's description(18) of *Pyropolyporus merrillii* states that the type contains "no cystidia" and that it was collected in Culion "on decaying trees near the seashore, December, 1902, by *E. D. Merrill, No. 3575.*" On page 478, just preceding the original description of *P. merrillii,* Murrill cites *Pyropolyporus endotheius* also under No. *3575* but only with the data "Culion: *Merrill 3575.*"

Graff(10) reports under *Fomes merrillii* (Murr.) Sacc. and Trott. [Saccardo Syll. Fung. 21 (1912) 287] a No. *3575* "Culion: December, 1902, *Merrill 3575,* on decaying tree trunks near the seashore." He also cites(11) *Fomes endotheius* "Culion: December, 1902, *Merrill 3575.*" These citations appear to have been taken from the literature rather than the specimens, since there are not two collections at the Bureau of Science marked No. *3575* and he specifically states(10) in his introduction that "all the collections cited are preserved in the herbarium of the Bureau of Science Manila."

There is represented, however, in the Bureau of Science herbarium a No. *3570* with the following data "*Fomes fullageri* Berk. On decaying parts of living trees near the seashore. Culion, No. *3570, E. D. Merrill,* December, 1912. Det. Graff." while a portion of the same sporophore sent to the Baker herbarium, Los Baños, P. I., bears the legend "*Fomes merrillii.* On decaying portions of living trees. Island of Culion, No. *3570, E. D. Merrill,* Dec., 1902 Det. Bresadola." The date, 1912, on the Bureau of Science specimen is apparently a typographical error. No. *3575* was apparently not sent to Los Baños.

Since Murrill does not report *3570* it is to be presumed that this number applies to his type of *Pyropolyporus merrillii* which was inadvertently published as *3575.* This view is supported by the facts that the collector's data on No. *3570* agree rather closely with the data published under the original description and that the description fits the same specimen, rather than No. *3575.* It appears logical, therefore, to consider No. *3570* the type of *Fomes merrillii* (Murr.), while the No. *3575* referred by both Murrill and Lloyd to *Fomes endotheius* Berk.

should be considered, in the light of the specimen at the Bureau of Science, *Fomes pachyphloeus* Pat.

Bresadola mentions *Fomes merrillii* in one of his last critical papers(6) but only in comparison with *Fomes endotheius* Berk., from which he considers it distinct. He gives the size of pores and hyphæ in the type but says nothing about setæ, from which it is to be inferred that the specimen that he examined was the true type or cotype. His spore and hyphæ measurements differ slightly from similar measurements by us on No. *3570* but would readily fall within the normal range of variation.

Fomes pachyphloeus Pat. var. *inermis* Bresadola(5) was described from Polillo Island, Philippine Islands, and is represented in the Bureau of Science herbarium by a portion of a slice (*Bur. Sci. 10526*) (Plate 3, fig. 4; Plate 6, fig. 3). Bresadola states that it differs from the type in not having setæ. He considered it only an abnormality. An examination of the specimen shows that it possesses both types of setæ, although the smaller ones are few in number. It is, therefore, not worthy of varietal rank.

Fomes pachyphloeus Pat. var. *stipitatus* Bresadola(3) was created to cover a specimen from Java with a short lateral perpendicular stipe. Bresadola states that in other respects it agrees well with the type. It would, therefore, be a form only, rather than a variety.

MATERIAL OF FOMES PACHYPHLOEUS EXAMINED

Of the forty-four specimens critically studied all were from the Philippines except four; namely, one from southern Nigeria (Plate 5, fig. 5), distributed by the Kew Herbarium and probably determined by Miss E. M. Wakefield; one from Indo-China sent by Patouillard (Plate 3, fig. 9; Plate 5, fig. 3); and two from the Federated Malay States, forwarded by E. J. H. Corner from the Singapore herbarium.

They were all properly determined either as *Fomes pachyphloeus* or *Elfvingia elmeri* Murr., with the exception of one specimen (*36065*) called *Fomes robinsoniae* Murr. by Lloyd (Plate 2, figs. 3 and 4) and the specimen erroneously deposited in the Bureau of Science herbarium as the cotype of *Pyropolyporus merrillii* Murr. Three specimens listed(9) by Graff [*Clemens "s n," Forestry Bur. 6419* (possibly an error for *6491*), and *19222*] are missing from the Bureau of Science and the Baker herbaria. In all there are eight determinations or con-

firmations by Bresadola, two by Corner, six by Graff, four by Lloyd, two by Patouillard, and one by the Kew Herbarium, available for study. These specimens are all deposited in the Bureau of Science herbarium at Manila or in the Baker herbarium at Los Baños, sometimes in both. To Dr. G. O. Ocfemia, of the Department of Plant Pathology, College of Agriculture, Los Baños, we are deeply indebted for the privilege of examining the specimens of the latter herbarium.

DESCRIPTION OF SPOROPHORES OF FOMES PACHYPHLOEUS

SHAPE AND SIZE

Mature specimens of *Fomes pachyphloeus* vary from compressed hemispheric through ungulate to applanate, often attaining large size (Plates 1 to 4). Young specimens may appear as thick cushions or as compressed hemispheric pilei (Plate 2, figs. 5 and 9). One specimen (*50126*) collected on Mount Maquiling, Luzon, Philippine Islands, was 26 inches broad, 15 inches long, and 8.5 inches thick through two pilei which coalesced at the base (Plate 1, fig. 1). It weighed 14.3 kilograms (31.5 pounds) after removal from the log and drying for ten days during warm dry weather.

The sporophores are sometimes abundant on fallen trunks and on standing trees often appear high on the bole. When growing from the underside of logs not resting directly on the ground they may be attached at the center of the back or broadly effused in a resupinate condition behind (Plate 4, fig. 3). They are usually single, but occasionally two or three pilei may be loosely imbricated and coalescent behind (Plate 1, fig. 10). In rare instances a new pileus may originate from the lower surface of an old blackened one, much as they do in *Ganoderma lobatum* (Schw.) Atk. Blackened burl-like growths (Plate 4, fig. 4) may develop occasionally on the trunks of living trees, the one at hand being of light weight, corky (much like ground pressed cork), and brown, mottled with white, within (Plate 4, fig. 5), the entire outer surface being sterile, hoary brownish-black, roughly tubercular and abundantly fissured.

CONSISTENCY

The fungus is frequently of light weight when dry, particularly the young forms. When in a freshly growing condition the sporophores are usually saturated with water and heavy. The large specimen (*50126*) previously mentioned, after ten days of drying still weighed 31.5 pounds, but after another thirty-five

days in a hot laboratory during the dry season was reduced to 13.5 pounds, a loss of nearly 60 per cent of its original weight. This wet condition frequently leads to extensive cracking or fissuring (Plate 1, figs. 3 and 4; Plate 4, fig. 2), particularly of the pore surface, when the plant dries rapidly.

UPPER SURFACE

The upper surface is usually sulcate, often tuberculose, and not uncommonly radiately ridged, with the margin varying from subacute to bluntly rounded. Except in very young specimens, or at the young growing margins, the plant is provided with a distinct crust, varying from brownish black to black in section, and about 0.1 millimeter to 3 millimeters in thickness. This is much cracked in age, often becomes loosened, and has a tendency to flake away (Plate 3, figs. 5, 6, 10 and 11).

The younger specimens are, in general, of varying shades of brown, the youngest, or the growing margins of some of the older specimens, varying from near buckthorn brown (R) [quite similar to certain young specimens of *Polyporus gilvus* (Plate 3, fig. 12)] to clay color (R) or tawny olive (R). One collection of one to two seasons' growth is quite strikingly zoned, in the dried state being Saccardo's umber (R) near the margin, followed by narrow zones of dark grayish brown (R) and pallid mouse gray (R), with drab and hair brown (R) zones behind (Plate 2, fig. 6). When fresh the specimens were recorded as buffy brown (R) at the margin, grayish olive (R) behind, and narrowly zoned with blackish. In general, however, color zonation is not a conspicuous feature.

Other specimens vary from cinnamon brown (R) to Prout's brown (R). Many become dark, particularly in age, then varying from Chaetura drab (R) to blackish slate (R).

LOWER SURFACE

The lower surface may be nearly plane to convex, occasionally concave, and is sometimes perforated by numerous insect holes about 1 millimeter in diameter and extending in for 1 to 2 centimeters (Plate 3, fig. 2). It also frequently cracks in drying (Plate 1, figs. 4 and 7), the crevices thus opened up sometimes being 1 to 1.5 centimeters wide. This cracking, however, is largely dependent upon the moisture content of the specimen and the rate at which it dries; some sporophores show no indication of it.

Field notes on four collections indicate that the colors of newly collected specimens vary from olive green [Saccardo's umber tinged with brownish olive (R) when dry], raw umber (R) [sepia (R) when dry], light brownish olive (R), sepia (R) on bruising [near olive brown (R) on drying, bister (R) where bruised], clay color (R) to near snuff brown (R) [near argus brown (R) when dry]. It will thus be noted that olivaceous shades predominate in the fresh material.

In the series of forty-four collections examined, all of which were dry and some of them sublimated, the colors fall into four principal groups: Yellowish browns, drab browns, olive browns, and deep browns. The first is rare, the others well represented. Of the Ridgway colors the following were noted: slightly darker than isabella color (one specimen), near cinnamon drab (Nigerian specimen), between benzo brown and hair brown, near fuscous, near fuscous black, snuff brown, Saccardo's umber, near argus brown, near cinnamon brown (specimen from Federated Malay States), near mummy brown, sepia, and near olive brown.

CONTEXT

The context (Plates 2, 3, and 4; Plate 7, figs. 6 and 7) varies from thin (sometimes almost lacking with the pores seated very close to the hard crust) to 3.5 centimeters in the specimens cut, although in very large specimens it is probably thicker. It is often obscurely zoned and is composed of radiating fibers, the consistency varying from soft corky to woody.

There is comparatively little variation in the color, young or immature specimens usually being tawny olive (R) with a silky sheen. In the mature Nigerian specimen it is near Brussels brown (R). In Philippine specimens it darkens with the age of the sporophore, the Ridgway colors noted in the older plants being near snuff brown, tawny olive, and antique brown with fine longitudinal streaks of white, or antique brown mottled with white and fuscous black.

PORES

The pores (Plates 2, 3, and 4; Plate 7, figs. 6 and 7; Plate 10, figs. 1 to 4) are small and only obscurely set off from the context, the color in longisection ranging around cinnamon brown (R), buckthorn brown (R), and Dresden brown (R). They are usually indistinctly stratified and more commonly with only a few layers of seasonal growth. One ungulate specimen, how-

ever, had thirteen layers (Plate 4, fig. 2). The seasonal growth rarely exceeds 3 centimeters and is very often only a few millimeters. Usually there is no sterile tissue between the layers, but Patouillard (24) reports such sterile layers of tramal tissue in a specimen from Annam, and they are shown to a slight degree in one specimen from the Federated Malay States. Occasionally the layers have a tendency to separate in dry material, and sometimes there is an infiltration of the hard blackish crust substance between them. This same infiltration may also occur vertically through the older pore layers, in which case they become very hard. Usually they are soft corky to firm corky, although occasionally woody. In most cases they can be broken out with the thumb nail.

The orifices, at the surface, vary from subangular to angular, rarely circular (Plate 10, figs. 1 to 3), but in cross section they are for the most part circular to subcircular. They are quite variable in size, the averages of five measurements on each of nine dried specimens from eight collections ranging from 6.4 to 10 per millimeter (6.4, 6.4, 7.4, 7.6, 8.6, 9.0, 9.5, 9.5, 10.0). The dissepiments are usually thin. They may be entire or may show all stages between slight and marked erosion. At times they are entirely occluded at the surface and in one instance the surface was distinctly raduloid (Plate 10, fig. 4).

TECHNIC

Microscopic measurements of hyphæ and spores were made with a 1/12a fluorite oil-immersion objective and 10x Huyghenian ocular, using a Leitz microscope, with a tube length of 160 millimeters, while colors of these elements were observed with the No. 6 (4-millimeter) objective and the same ocular. Photomicrographs of spores were made from crushed mounts of the pores in 7 per cent potassium hydroxide, using the 1/12a oil immersion and 8x ocular. Other elements were photographed with various combinations of dry objectives and the higher oculars, as indicated by the magnifications given in the plate descriptions. Sections were all free-hand, of material soaked in 7 per cent potassium hydroxide.

Approximately 310 pore hyphæ, 280 context hyphæ, 270 pore setæ, 260 context setæ, and 100 spores, from 22 collections, were measured.

Pore surfaces of three representative specimens were photographed through a 35-millimeter Zeiss Planar lens fitted to a Leitz microscope with 6x ocular and 160-millimeter tube length,

using the small Bausch and Lomb fixed-bellows camera. The number of pores per millimeter was determined by use of a millimeter celluloid scale and a hand magnifier.

Colors were compared with those in Ridgway's Color Standards and Color Nomenclature and all direct comparisons are indicated by (R) following the color name.

MICROSCOPIC STRUCTURE

All parts of the sporophore contain abundant, subacute to rather blunt, yellowish brown to dark reddish brown, elongate, thick-walled, seta-like bodies (Plates 5 and 6; Plate 7, figs. 1, 3, 4, and 5) which follow the course of the regular hyphæ and sometimes project through the young crust (Plate 7, fig. 2; Plate 9, fig. 6). Patouillard(23) reported a young Tonkin specimen as having the charateristic crust only over the posterior portion of the sporophore with the anterior portion provided with a compact velvety covering consisting of erect cystidiform bristles analogous to those in the trama and stated that, after collecting, the same organs were produced on the inner surface of the bark, the growth resembling the hymenial surface of a Hymenochæte. In another paper(22) he states with reference to a specimen from Cambodia that in all its parts, tubes, trama, and even the crust one finds the long cystidiform filaments characteristic of the species.

In the pore walls these seta-like organs run parallel with the thinner walled yellowish-brown dissepiment hyphæ which are compactly arranged longitudinally, although occasionally somewhat oblique. Ordinarily the tips do not project through the hymenium, although there is a slight tendency to do so at the extremity of the dissepiments (Plate 6, figs. 7, 8, and 9). In the context they follow the course of the obliquely arranged hyphæ composing it (Plate 7, figs. 1 and 5).

These setuliform bodies vary greatly in length and apparently arise from the modification of the ends of the regular hyphæ. Sometimes they closely resemble normal setæ, there being an abrupt change from hypha to seta (Plate 9, fig. 7), but usually there is a very gradual transition in color, size, and shape. They are usually quite straight but curved or somewhat flexuous ones are not uncommon. Two hundred thirty measurements made on seventeen collections (ten for each specimen) gave limits of 46.9 μ to 264.2 μ in length and 8.7 to 20.9 μ in width, with an average of 104.64 μ for the length and 12.45 μ for the width.

In addition, small, usually ventricose, setæ (Plates 5 and 6; Plate 7, figs. 3 and 4; Plate 9, fig. 8) of the same general color, although frequently lighter, arise in greater or less abundance from the subhymenial hyphæ. These are also thick walled, straight, or sometimes curved, and are acute at the tip. They are quite loosely seated and tend to break out in sectioning. Two hundred thirty measurements from the specimens noted in the preceding paragraph yielded variations in length from 12.2 to 29.5 μ and in width from 3.5 to 8.7 μ with averages of 18.06 and 5.88 μ, respectively.

The dissepiment hyphæ (Plates 5 and 6; Plate 7, figs. 3 and 4) are rather compact, run generally parallel to the walls of the pores, and are yellowish brown [old gold (R) to buckthorn brown (R) under the high power of the microscope], with moderately thin to rather thick walls. They average 3.12 μ for two hundred thirty measurements, varying between 1.7 and 5.2 μ.

The context hyphæ (Plate 7, figs. 1 and 5) are of the same color, appear to be somewhat thinner walled, more loosely arranged, and with a greater tendency to collapse. They show the same variation in size as the dissepiment hyphæ, with nearly the same average diameter (3.18 μ for two hundred twenty measurements). They may run parallel to the crust or obliquely to it. The crust (Plate 7, figs. 1 and 2) is composed of compact thick-walled hyphæ, usually with a general vertical arrangement. They are so compact, however, that they almost lose their identity.

In the original description Patouillard(20) records the spores as subglobose, colorless under the microscope, smooth, 5 to 6 μ. Later(24) he gives them as subglobose, straw colored, 4 μ, for a specimen from Annam. Bresadola(2) records them as globose, stramineus, 3 to 5 μ, in the specimen from Kamerun cited by Patouillard in the original description, and for Philippine material(4) as globose, 5 to 6 by 4.5 to 6 μ. Lloyd(16) gives them as rare, globose, 8 μ, pale colored. For *Elfvingia elmeri* Murrill(18, p. 476) reports them as ferruginous, globose, smooth, 5 to 6 μ.

The writers have examined all the specimens available and have found only three collections with spores. In one they were abundant, in the others scarce. They vary from nearly colorless, but with a slight tinge of yellow, to near snuff brown (R) (in water or 7 per cent potassium hydroxide) under the high power of the microscope. As a rule they are globose to sub-

globose, but some tend toward subelliptic or ovate (Plate 10, figs. 5 and 6). The walls are smooth and moderately thick. Many are uniguttulate. The three collections were examined in crushed mount. In one the spores were 4.2 to 4.9 by 4.5 to 4.9 μ, with an average (10 measurements) of 4.5 by 4.6 μ. In another they were 4.2 to 5.4 by 4.2 to 5.6 μ with an average (30 measurements) of 4.7 by 4.9 μ. In the third (*Bur. Sci. 50280*) they were 2.8 to 3.5 by 3.5 to 4.2 μ, averaging (40 measurements) 3.3 by 4.0 μ. This last specimen is a rather thin shelving form, effused behind, with aberrant upper surface characters, approaching light seal brown (R) and narrowly sulcate. The spores (Plate 10, fig. 5) are copious and dark, as compared with the other two specimens. The under surface and the structure are sufficiently typical for the species, however, although the setiform bodies of the dissepiments run rather erratically and often project into the pores, and the pore setæ are less ventricose and taper rather gradually to an acute point.

SPECIMENS EXAMINED

AFRICA

Southern Nigeria, Agolo, Obu, *N. W. Thomas* (*Herb. Hort. Bot. Reg. Kew*) (B).[2]

FEDERATED MALAY STATES

Johore, Bagan Limau, Sungu Sedili, on living tree, *E. J. H. Corner 24491* (S; B. S.), Pahang, Tembeling, on dead *Ficus*, *E. J. H. Corner 24197* (S; B. S.).

INDO CHINA

Cambodia, Reserve forestière de Compong Chhnang, on rotten trunk, *Herb. Patouillard 273* (B. S.).

PHILIPPINE ISLANDS

BASILAN, Isabela, on living *Hopea* sp., *H. S. Yates 36065* (B. S.).

CULION, on prostrate log, *E. D. Merrill 3575* (Specimen marked in error as cotype of *Pyropolyporus merrillii* Murr.) (B. S.).

[2] Abbreviations are given in parenthesis, following the number, to indicate the herbaria in which the specimens cited are deposited. Thus, (B) refers to the Baker herbarium, at Los Baños, Philippine Islands; (B. S.) to the Bureau of Science, Manila; and (S) to the Singapore herbarium.

LUZON, locality unknown, *50153* (B. S.).

Bataan Province, *H. M. Curran, Forestry Bureau 19240* (B. S.), Lamao, on dead *Albizzia procera* (Roxb.) Benth., *H. M. Curran 19253* (B. S.), *15587* (B. S.; B), Morong, on stump of *Parkia javanica* (Lam.) Merr., *H. M. Curran, Forestry Bureau 6491* (B. but not B. S.), Mount Mariveles, *A. D. E. Elmer 6961* (cotype of *Elfvingia elmeri* Murr., in *Elmer herbarium*), on fallen *Pentacme contorta* (Vid.) Merr. and Rolfe, *C. J. Humphrey 50147* (B. S.), on nearly dead *Pentacme contorta, C. J. Humphrey 50148* (B. S.), on living *Hopea acuminata* Merr., *C. J. Humphrey and L. Reyes 50144* (B. S.), on fallen *Shorea guiso* (Blco.) Blm., *C. J. Humphrey and L. Reyes 50279* (B. S.).

Bulacan Province, Sibul Springs, *C. J. Humphrey 50149* (B. S.).

Laguna Province, Los Baños, *A. D. E. Elmer, Philippine Islands Plants 18328* (B. S.), Mount Maquiling, *C. F. Baker 3962* (B), on large nearly dead *Parashorea malaanonan* (Blco.) Merr., *C. J. Humphrey 50137* (B. S.), on fallen trunk, *C. J. Humphrey 50126* (B. S.), *50128* (B. S.), *50129* (B. S.), on stump of *Pentacme contorta* (Vid.) Merr. and Rolfe, *C. J. Humphrey 50155* (B. S.), on nearly dead *Pentacme contorta* (Vid.) Merr. and Rolfe, *C. J. Humphrey 50142* (B. S.), on fallen log, *P. W. Graff 21032* (B. S.), on fallen trunk *Parashorea malaanonan* (Blco.) Merr., *C. J. Humphrey 50138* (B. S.), on fallen trunk, Pangil, *C. J. Humphrey 50130* (B. S.).

Pampanga Province, Mount Arayat, *M. S. Clemens 1612* (B. S.).

Tayabas Province, Mount Cadig, *H. S. Yates 25728* (B. S.; B.).

Zambales Province, Olongapo, *M. S. Clemens 4551* (B. S.).

MINDANAO, Cotabato Province, Sarunayan, on small dead standing trunk, *C. J. Humphrey 50143* (B. S.).

Lanao Province, Lake Lanao, Camp Keithley, *M. S. Clemens "a"* (B).

Zamboanga Province, on living *Pentacme mindanensis* Foxw., *C. J. Humphrey 50145* (B. S.), on living *Hopea philippinensis* Dyer, *C. J. Humphrey 50154* (B. S.), on dead fallen mangrove, *Rhizophora candelaria* DC., Kabasalan swamp, *R. F. Wendover 50140* (B. S.), on dead fallen *Rhizophora mucronata* Lam., *R. F. Wendover 50141* (B. S.), on hollow nearly dead *Shorea negrosensis* Foxw., *C. J. Humphrey 50146* (B. S.), on fallen trunk, *C. J. Humphrey 50151* (B. S.), *50152* (B. S.), *50280* (B. S.).

PALAWAN, Mount Kabangaan, *Buenaventura Reyes 50156* (B. S.).

POLILLO, *R. C. McGregor 10526* (cotype of *Fomes pachyphloeus* Pat. var. *inermis* Bres.) (B. S.), *10554* (B. S.)

FOMES MAGNOSPORUS Lloyd.

This species was described(15) in 1914 from a specimen collected by H. A. Lee at Lamao, Bataan Province, Luzon, Philippine Islands. The single specimen (Plate 4, figs. 6 to 8) was found on *Canarium villosum* (Bl.) F. Vill., but whether on a fallen log or on a living tree is not stated. As it has never been found since, the only material at the Bureau of Science consists of approximately one-half a subapplanate sporophore which originally was about 20 centimeters wide. It is 12 centimeters long and 7 centimeters thick at the base, rather irregular in shape, and imperfectly developed.

The upper surface is very uneven, uniformly near to bister (R), and gives the impression that new abortive coalescent pilei have developed upwards from the original surface. It is somewhat rough to the touch, but under a 14x hand lens appears finely pubescent (Plate 8, figs. 4 and 6); scrapings yield abundant, somewhat flexuous, pale hyphæ (Plate 9, fig. 4) but no setæ.

The lower surface is ascending, quite irregular, with a few abortive pilei forming here and there. The older areas are near Natal brown (R), while the younger growth is slightly darker than chamois (R).

The context is firm corky, becoming woody in places, and varies from near raw sienna (R), through Sudan brown (R), to Brussels brown (R). Streaks of the lighter color occur more or less parallel to the lower surface, and these correspond to abortive pore areas. The upper portion is the darkest and approaches Brussels brown. Rather obscure concentric zonation occurs throughout, consisting for the most part of mottled bands as shown in Plate 8, fig. 1.

The pores (Plate 8, fig. 1) are quite abortive, occurring in two interrupted zones separated by much sterile tissue. At the surface they are at best only shallow pits and are usually entirely lacking. At the few places they occur in the section of the sporophore they are approximately three to the millimeter and frequently stuffed, the maximum length at one spot being about 1 centimeter.

MICROSCOPIC STRUCTURE

In the pore walls and context occur a few scattered seta-like bodies (Plate 8, figs. 2, 3, 5, and 7; Plate 9, figs. 2 and 5) of the same general form as in *Fomes pachyphloeus*, but often somewhat lighter in color. These range from 5.2 to 8.6 μ wide to 26 to 60 μ long, with an average of 6.5 by 38 μ for five measurements. None were observed in the crust. No small setæ, such as are characteristic of *F. pachyphloeus*, occur in the hymenium, but occasionally the long dissepiment setæ may project slightly into the pores.

The context (Plate 9, figs. 1, 3, and 5) is composed of compactly arranged, rather thick-walled to very thick-walled hyphæ generally running horizontally, with an occasional darker seta-like hypha intermixed. These context hyphæ are quite variable in size and wall thickness, the lumen being almost closed in many of them. A tangential section shows them to be fused to a large extent, so that the preparation appears as a porous mass (Plate 9, fig. 3). While the general tendency is parallel there are some areas in which they are considerably intertwined. The color is golden to yellowish brown in thin sections. The size varies from 2.5 to 7.1 μ, with an average (50 measurements) of 4.1 μ.

The dissepiment hyphæ (Plate 8, figs. 2, 3, 5, and 7; Plate 9, fig. 2) are essentially the same color as those of the context, compact, usually rather thick walled, and with a general parallel arrangement. In size they vary from 2.1 to 5.6 μ, with an average (40 measurements) of 3.6 μ. Scattered in the tissue are a few of the much darker seta-like hyphæ, which offer considerable contrast in size and color.

The spores (Plate 10, fig. 7) are copious in crushed mount, but have not been observed attached to basidia, since the hymenium is badly disorganized. They lie along the pore walls in considerable numbers, however. In the absence of any foreign mycelium in the sections it would thus appear that they pertain to the species. They are globose, or nearly so, often granular within, distinctly apiculate, thin walled to medium thick walled, the thin-walled ones sometimes collapsing. The color is rather unusual, varying from very dilute vinaceous lavender (R) to deep purplish vinaceous (R) for the apparently more mature ones, which are fewer in number than the paler ones. When measured at right angles to an axis through the apiculus they give an average of 7.5 μ (50 measurements), varying between

6.8 and 8.5 μ. Lloyd gives them 11 to 12 μ, but we have found none that large.

There is a somewhat general resemblance between *Fomes magnosporus* and *Fomes pachyphloeus* but the microscopic features will readily separate them. The points of particular contrast are as follows:

Pore setæ present in *pachyphloeus*, not in *magnosporus*.

Context setæ quite similar in appearance in both but usually abundant in *pachyphloeus*, few and scattered in *magnosporus* and lacking in the crust of that species.

Spores usually globose, but tending to subelliptic or ovate, slightly tinged with yellowish to near snuff brown, not exceeding 6 μ in diameter in *pachyphloeus;* globose, very dilute vinaceous lavender to deep purplish vinaceous, varying from 6.8 to 8.5 μ in diameter in *magnosporus*.

SUMMARY

A detailed microscopic examination of forty-four specimens of *Fomes pachyphloeus* Pat. coming from the Philippines, Africa, Federated Malay States, and Indo-China was made. All the specimens were found to agree closely in micro-characters, although the consistency and spores offered considerable variation. The distinguishing characters consist in the presence of small brown setæ in the pores, and large brown setæ or seta-like hyphæ throughout the tissues and extending through the crust.

The type collection of *Fomes magnosporus* Lloyd was examined in comparison with *pachyphloeus* and found to differ in microscopic structure sufficiently to maintain it as a distinct species, the principal differences being the lack of pore setæ, the comparatively few large setæ or seta-like hyphæ in the context and pore walls but not in the crust, and the size and color of the spores.

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ILLUSTRATIONS

PLATE 1

FOMES PACHYPHLOEUS PAT.

FIG. 1. Upper surface of a large sporophore, 27.5 inches wide, *50126* (B. S.), Luzon, P. I. The young lady is the junior author; × 0.06.
2. Upper surface of *50148* (B. S.), Luzon, P. I.; × 0.20.
3. Front-side view of *50138* (B. S.), Luzon, P. I., showing fissuring after drying; × 0.44.
4. Front view of another specimen of *50138*, showing cracking of the lower surface; × 0.32.
5. Upper surface of a small specimen of *50138;* × 0.36.
6. Upper surface of a strongly sulcate specimen of *50138;* × 0.32.
7. Lower surface of an old blackened sporophore of *50138*, with excessive cracking; × 0.32.
8. A very young nodular sporophore from *Pentacme contorta*, *50148* (B. S.); × 0.35.
9. Sporophore on *Rhizophora candelaria* DC., *50140* (B. S.), Mindanao, P. I.; × 0.10.
10. Front-top view of an irregular sporophore, *50146* (B. S.), Mindanao, P. I.; × 0.39.

PLATE 2

FOMES PACHYPHLOEUS PAT.

FIG. 1. Upper surface of a rather hard, heavy, narrowly sulcate sporophore, *50145* (B. S.), Mindanao, P. I.; × 0.30.
2. Under surface of *50145* shown in fig. 1, with only slight cracking; × 0.28.
3. Upper surface of a sporophore, *36065* (B. S.), Basilan, P. I., determined by Lloyd as *Fomes robinsoniæ;* × 0.35.
4. Section of *36065* shown in fig. 3; × 0.39.
5. A young compressed-hemispheric sporophore, with section, *Clemens 1612*, Luzon, P. I.; × 0.42.
6. Upper surface of a young, zonate, corky, light-weight sporophore, *50149*, (B. S.), Luzon, P. I.; × 0.29.
7. Lower surface of *50149* shown in fig. 6; × 0.29.
8. Section of *10554* (B. S.), Polillo, P. I., determined by Bresadola. Note the fibrous character of the context and the fine pores; × 0.29.
9. Abortive fructification of *21032* (B. S.), Luzon, P. I., determined by Bresadola; × 0.39.
10. Section of *50149* shown in figs. 6 and 7; × 0.42.

Plate 3

Fomes pachyphloeus Pat.

Fig. 1. Front view of an ungulate-hemispheric sporophore, *50143* (B. S), Mindanao, P. I.; × 0.28.

2. Lower blackened surface of *50143* shown in fig. 1. Note the numerous insect holes; × 0.29.
3. Section of a more typical sporophore of *50143;* × 0.30.
4. Section of *Fomes pachyphloeus* Pat. var. *inermis* Bres., *10526* (B. S.) (cotype), Polillo, P. I.; × 0.29.
5. Section of *Elfvingia elmeri* Murr., *Elmer's Philippine Islands Plants 6961* (cotype), Luzon, P. I.; × 0.27.
6. Upper surface *6961* shown in fig. 5; × 0.27.
7. Side view from above of the specimen marked as the cotype of *Pyropolyporus merrillii* Murr., *3575* (B. S.), Culion, P. I. This is typical *F. pachyphloeus* and was apparently mislabeled. It has no affinities with *P. merrillii;* × 0.36.
8. Section of *3575* shown in fig. 7; × 0.36.
9. Young atypical specimen in the Bureau of Science from Patouillard (*273*), Cambodia, Indo-China; × 0.29.
10. Section of *19240* (B. S.), Luzon, P. I. Determined by Bresadola; × 0.27.
11. Upper surface of *19240* shown in fig. 10. Note the flaking crust, which is not an unusual feature of the species; × 0.25.
12. Upper surface of a very young atypical specimen with almost the same coloration as young *Polyporus gilvus* Schw., 50147 (B. S.), Luzon, P. I.; × 0.39.
13. View from behind of *50156* (B. S.), Palawan, P. I., showing a specimen with a strongly concave upper surface; × 0.17.
14. Upper surface of half of an old, hard, blackened sporophore, *50142* (B. S.), Luzon, P. I.; × 0.37.
15. Side view of a small ungulate form of *50142;* × 0.36.
16. Upper surface of another specimen of *50142;* × 0.37.

Plate 4

Fomes pachyphloeus Pat. and Fomes magnosporus Lloyd

Fig. 1. Side-front view of *F. pachyphloeus*, 50137 (B. S.), Luzon, P. I. This is of rather unusual shape; × 0.30.

2. Section of *50137* shown in fig. 1. Note the cracks extending through the pore layers; × 0.31.
3. Side view of an irregular sporophore of *F. pachyphloeus* broadly attached behind, *50128* (B. S.), Luzon, P. I.; × 0.31.
4. Burl-like, abortive, sterile growth of *F. pachyphloeus* on *Rhizophora mucronata* Lam., 50141 (B. S.), Mindanao, P. I.; × 0.27.
5. Section of *50141* shown in fig. 4; × 0.37.
6. Side view of *Fomes magnosporus* Lloyd, *48* (B. S.) (cotype), Luzon, P. I. Note the young nodular pilei developing from the convex lower surface; × 0.25.
7. Front-upper surface view of the specimen shown in fig. 6; × 0.30.
8. Section of the specimen shown in figs. 6 and 7; × 0.39.

Plate 5

Fomes pachyphloeus Pat.

Fig. 1. Longisection of the pores of *Clemens "a"*, Mindanao, showing setæ in the walls. Determined by Bresadola; × 85.
2. Cross section of the pores of *Clemens "a"* showing setæ of varying size and wall-thickness; × 288.
3. Longisection of the pores of *Patouillard, 273*, Indo-China, with a number of the small hymenial setæ; × 85.
4. Longisection of the pores of *Elfvingia elmeri* Murr., *Elmer 6961* (cotype), Luzon, P. I.; × 85.
5. Longisection of the pores of the Nigerian specimen from Kew in the Baker herbarium; × 85.
6. Longisection of the pores of *3575* (B. S.), Culion, P. I. This specimen is marked in error as the cotype of *Pyropolyporus merrillii* Murr.; × 85.

Plate 6

Fomes pachyphloeus Pat.

Fig. 1. Longisection of the pores of *50149* (B. S.), Luzon, P. I.; × 64.
2. Cross section of the pores of *50149*, showing abundant large setæ in the walls and a considerable number of small hymenial setæ; × 64.
3. Longisection of the pores of *10526* (B. S.), Polillo, P. I. Cotype of variety *inermis* Bres. Note the few scattered hymenial setæ characteristic of the species; × 64.
4. Longisection of the pores of *50280* (B. S.), Mindanao, P. I.; × 64.
5. Longisection of the pores of *24197* (S; B. S.), Federated Malay States; × 64.
6. Cross section of the pores of *24197* (S; B. S.); × 64.
7. Longisection of pores at the tips, *50146* (B. S.), Mindanao, P. I. Note the few paler, slightly projecting, setæ at some of the tips; × 64.
8. Longisection of pores at the tips, *50149* (B. S.), Luzon, P. I.; × 64.
9. Oblique longitudinal section of pores at the tips of *50156* (B. S.), Palawan, P. I.; × 64.
10. Cross section of the pores of *10554* (B. S.), Polillo, P. I. Determined by Bresadola; × 216.
11. Cross section of the pores of *50151* (B. S.), Mindanao, P. I.; × 180.

Plate 7

Fomes pachyphloeus Pat.

Fig. 1. Radial section of the context just beneath the crust of *50149* (B. S.), Luzon, P. I., showing numerous dark seta-like hyphæ; × 42.
2. Radial section of the crust of *50149* with a single seta projecting through the surface; × 97.

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FIG. 3. Longisection of a single pore wall of *Clemens 4551* (B. S.), Luzon, P. I., showing the two types of setæ highly magnified.
4. Cross section of the pores of *Clemens 4551* at the same magnification as in fig. 3.
5. Radial section of the context of *50149*, showing abundant dark seta-like hyphæ; × 97.
6. Radial section of the context and pores of *50149;* × 4.
7. Radial section of the context and pores of *Elfvingia elmeri* Murr., *6961* (Cotype in Elmer herbarium); × 4.

PLATE 8

FOMES MAGNOSPORUS LLOYD, NO. 48, TYPE COLLECTION

FIG. 1. Longisection through the context and a small pore area near the margin. The mottling of the context is well shown above and below. There is a strong tendency to produce the *Myriodoporus* type of pores in certain areas, as shown here, but these are always stuffed; × 4.6.
2. Cross section of the pores. The seta-like hyphæ are not very distinct under low magnification. A few of them have been circled; × 33.
3. Cross section of same more highly magnified to bring out the relative size of the ordinary hyphæ and seta-like ones; × 248.
4. Section of the crust showing the loose, vertical arrangement of the hyphæ; × 33.
5. Longisection of the pores showing the few scattered seta-like hyphæ at low magnification; × 33.
6. Radial section of the crust at somewhat higher magnification than shown in fig. 4; × 73.
7. Longisection of the pores at a higher magnification than in fig. 5, showing two of the seta-like hyphaæ; × 73.

PLATE 9

FOMES MAGNOSPORUS LLOYD AND FOMES PACHYPHLOEUS PAT.

FIG. 1. Radial section of *Fomes magnosporus, 48*, through a compact portion of the context; × 288.
2. Longitudinal section of the pores of *Fomes magnosporus, 48*, at a much higher magnification than shown in Plate 8, fig. 7; × 288.
3. Tangential section of the same portion of the context as shown in fig. 1; × 288.
4. Hyphæ of *Fomes magnosporus, 48*, from scrapings from the upper surface. Such scrape mounts have never shown the presence of setæ, as they do in *Fomes pachyphloeus;* × 288.
5. Radial section of the context of *Fomes magnosporus, 48*, showing a single seta-like structure. These are rare in the context of this species; × 288.
6. Hyphæ and a typical seta from scrapings from the upper surface of *Fomes pachyphloeus, 50149* (B. S.), Luzon, P. I. Compare with *Fomes magnosporus*, fig. 4, which shows much larger hyphæ and no setæ; × 288.

FIG. 7. A context seta of *Fomes pachyphloeus, 10554* (B. S.), Pollilo, P. I., photographed from a crushed mount of the pores; × 288.

8. Hymenial setæ from crushed mounts of the pores of *Fomes pachyphloeus*, showing wide variation in size and shape, *a*, from *Elmer 18328; b*, from *Bur. Sci. 50145; c*, from *Bur. Sci. 50149;* × 288.

PLATE 10

FOMES MAGNOSPORUS LLOYD AND FOMES PACHYPHLOEUS PAT.

FIG. 1. Pore surface of *Fomes pachyphloeus, 50145* (B. S.), Mindanao, P. I.; × 20.

2. Pore surface of *Fomes pachyphloeus, 50149* (B. S.), Luzon, P. I.; × 20.

3. Pore surface of another specimen of *50149*, with thin-walled, eroded dissepiments; × 20.

4. Pore surface of *Fomes pachyphloeus, 15587* (B. S.), Luzon, P. I. Determined as *Elfvingia elmeri* Murr. by Bresadola. The pores are occluded, the pore surface being raduloid; × 20.

5. Spores from a crushed pore mount of *Fomes pachyphloeus, 50280* (B. S.), Mindanao, P. I. They are comparatively small and dark for the species; × 785.

6. Spores from a crushed pore mount of *Fomes pachyphloeus, 50149*. They range somewhat larger than the preceding and are paler in color; × 785.

7. Spores from a crushed mount of the type of *Fomes magnosporus* Lloyd, *48* (B. S.); × 785.

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50140, Philippines: Plate 1, fig. 9.

50141, Philippines: Plate 4, figs. 4 and 5.
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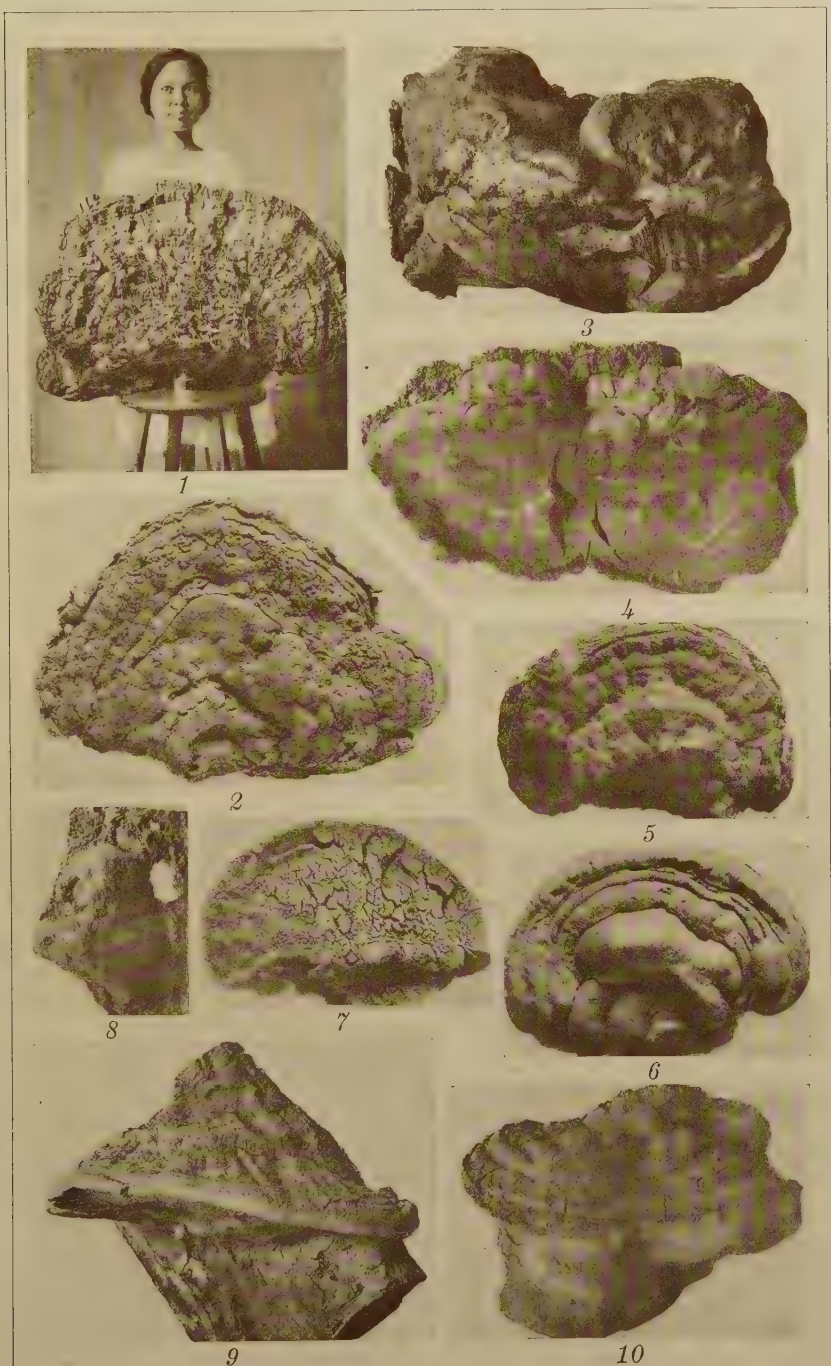
FOMES MAGNOSPORUS LLOYD

48, Philippines: Plate 4, figs. 6, 7, 8; Plate 8, figs. 1 to 7; Plate 9, figs. 1 to 5; Plate 10, fig. 7.



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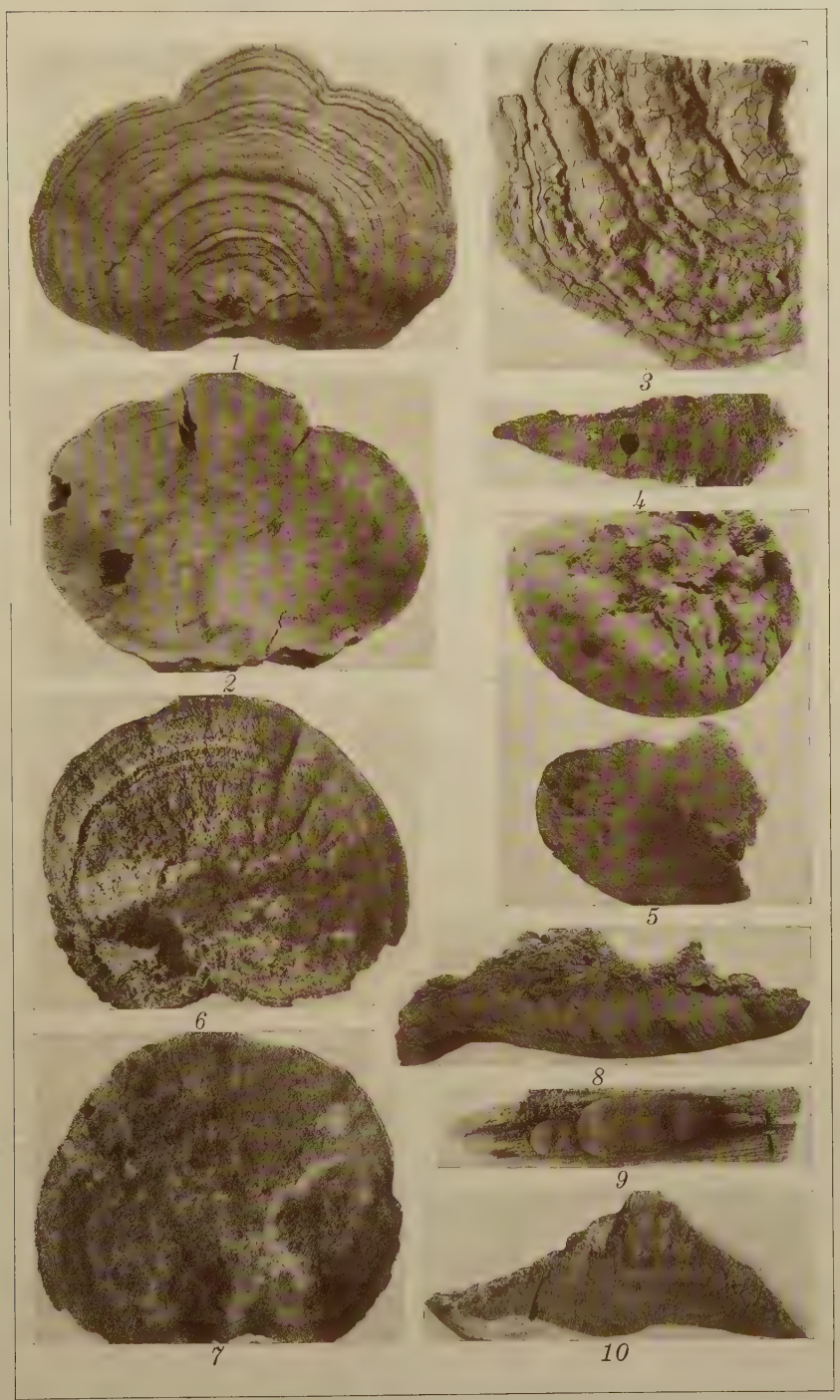

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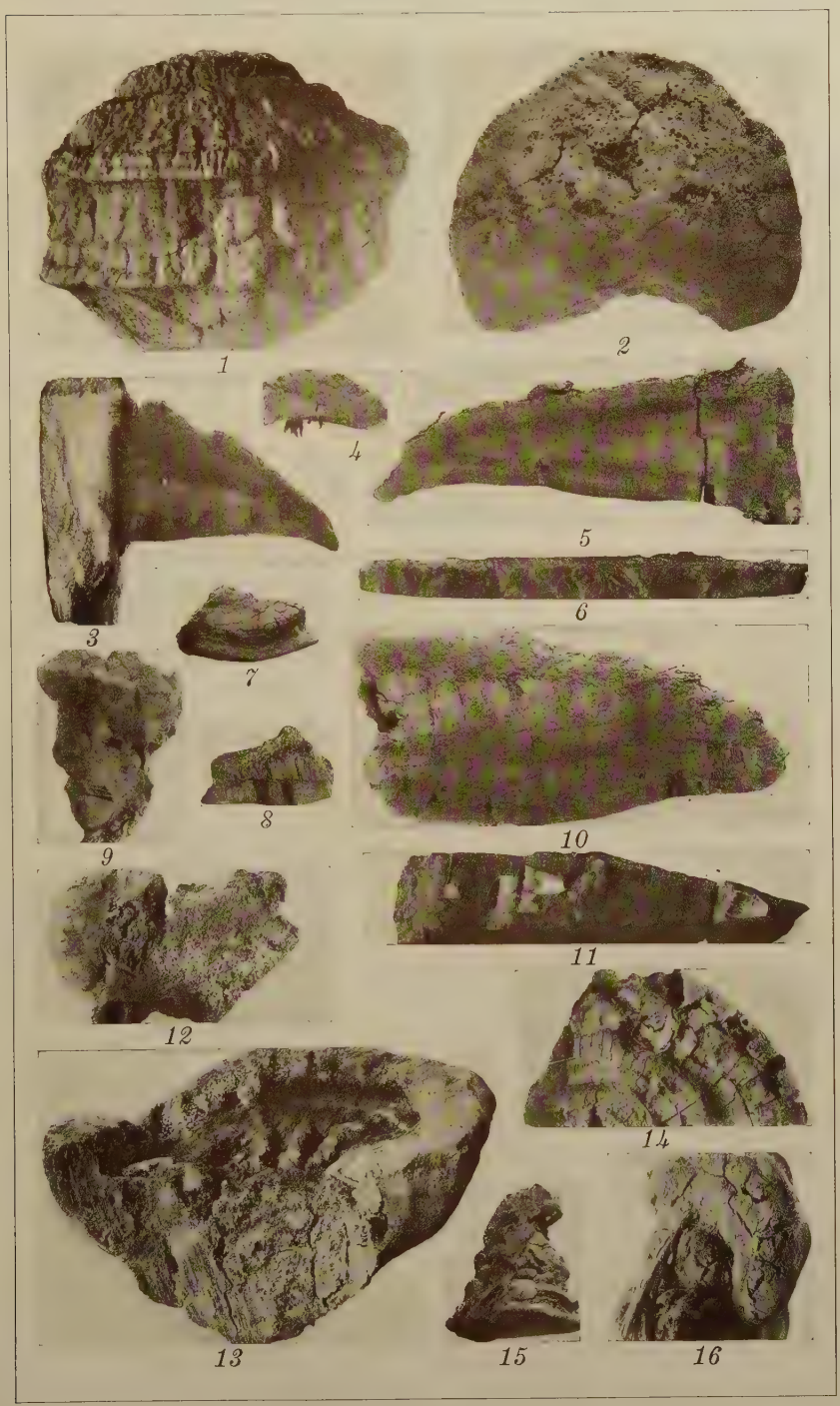

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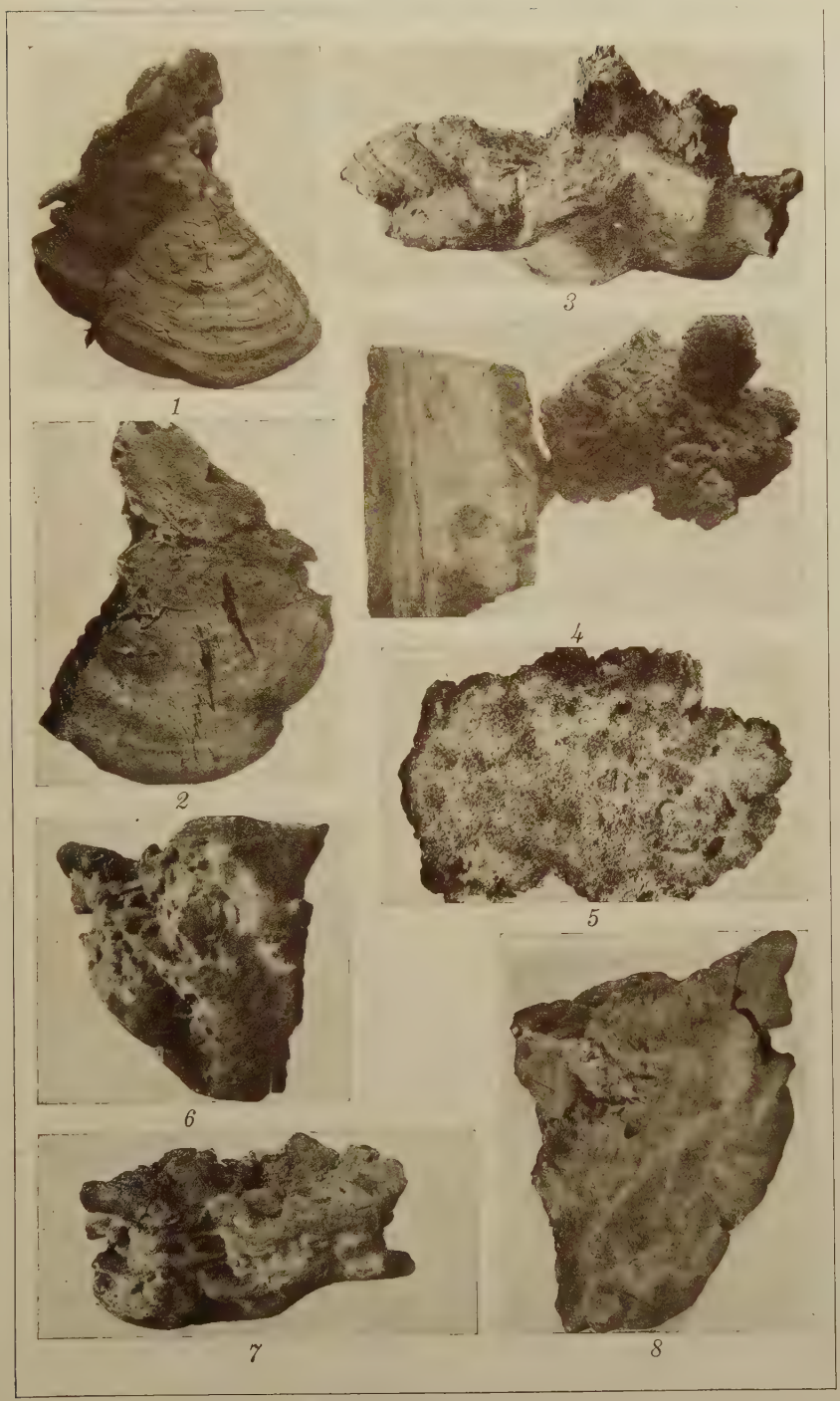
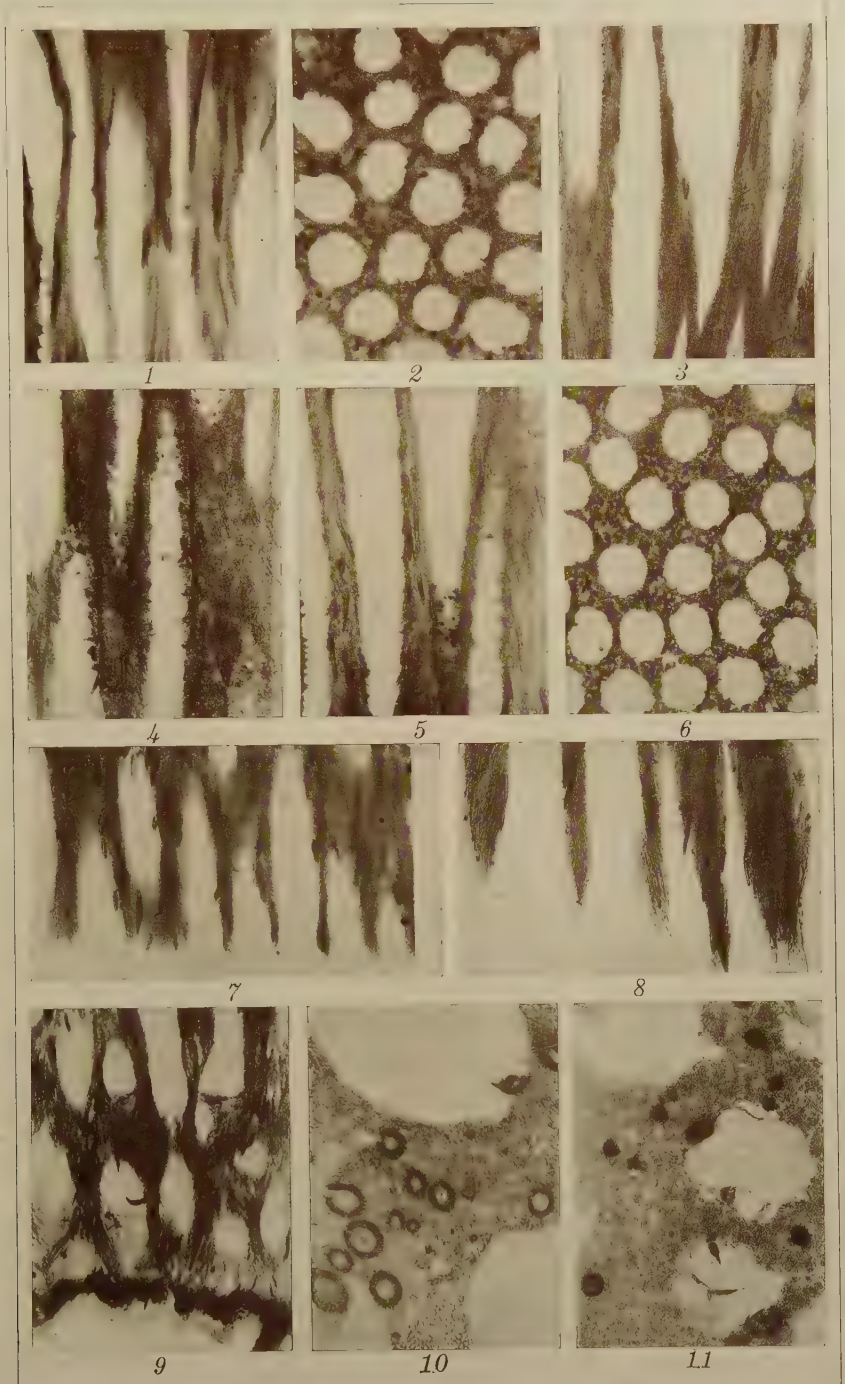


PLATE 4.

PLATE 5.



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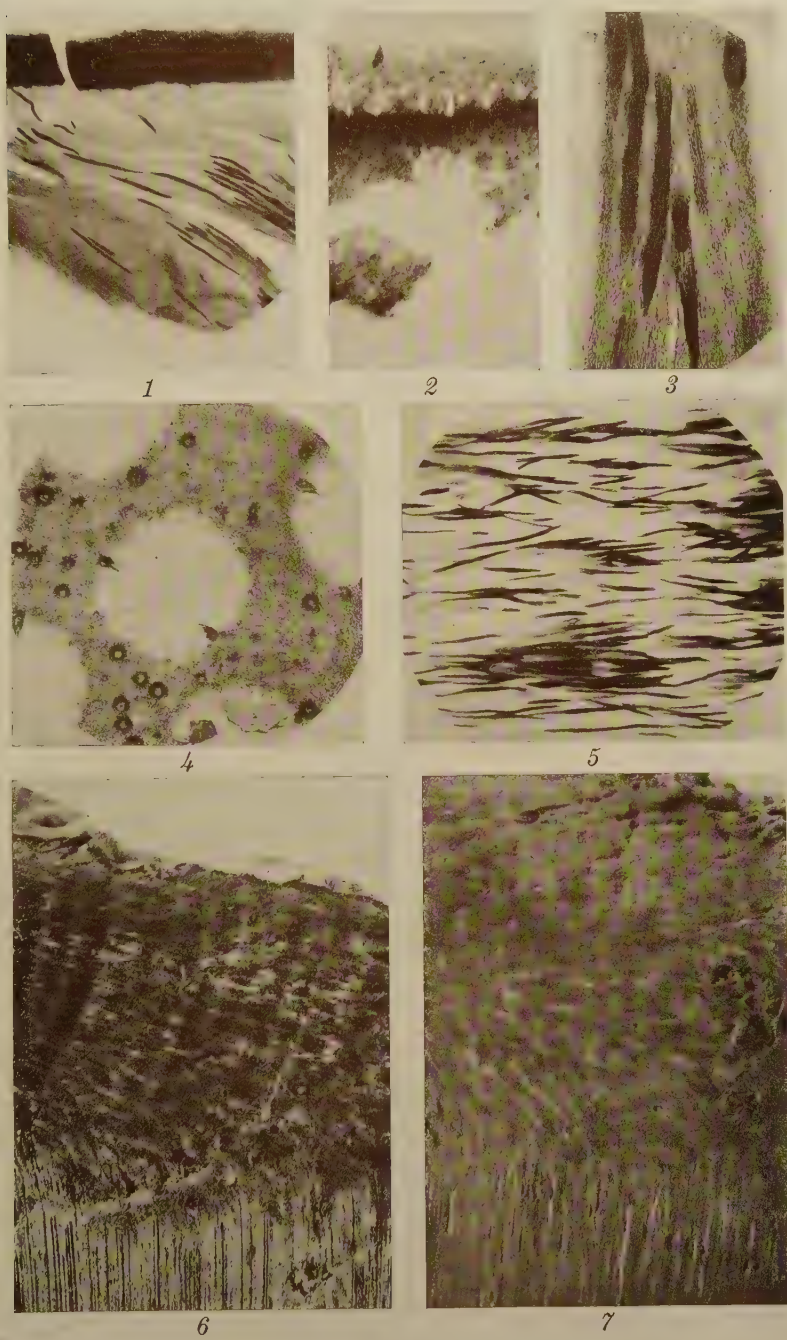

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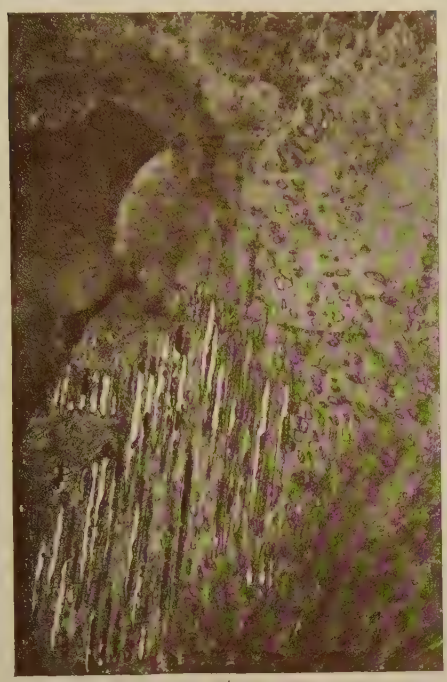

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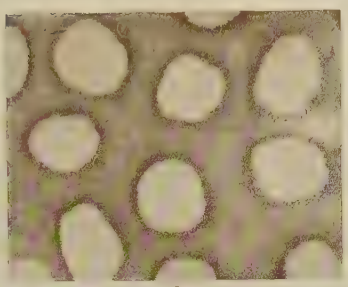

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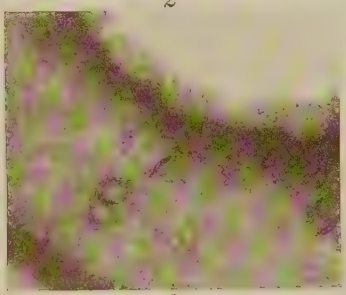

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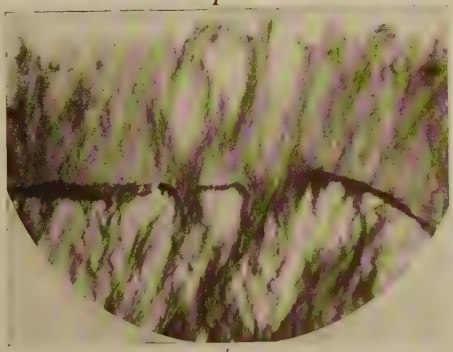

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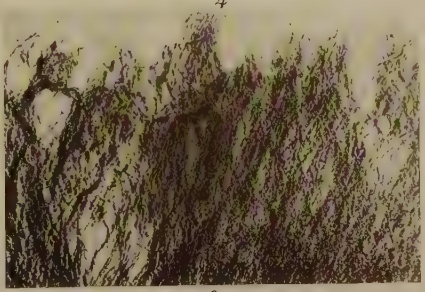

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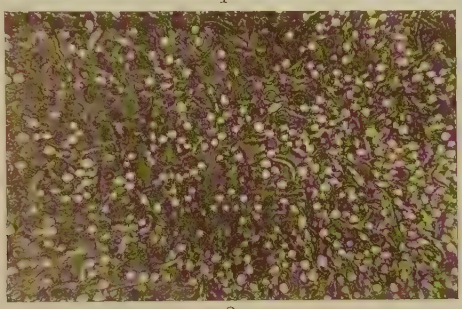

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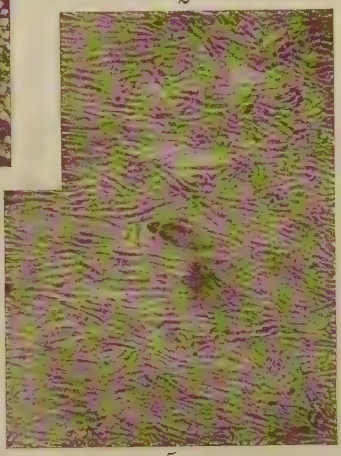

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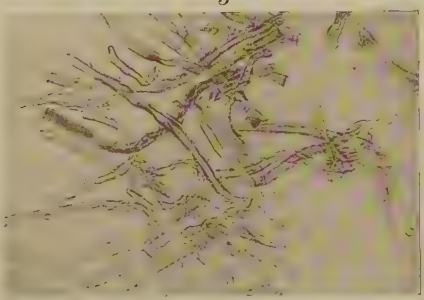

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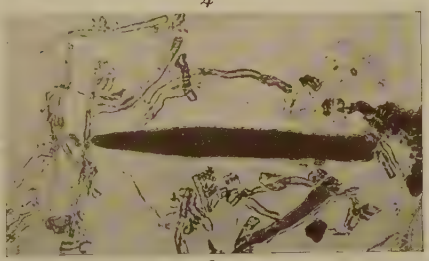

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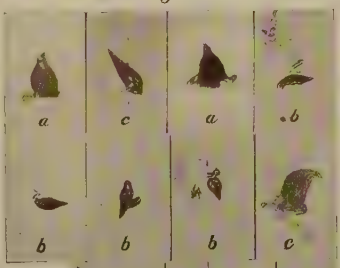

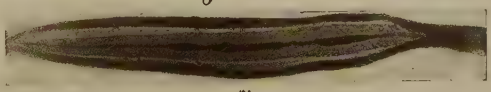

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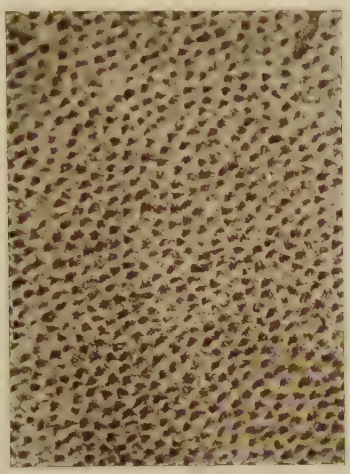

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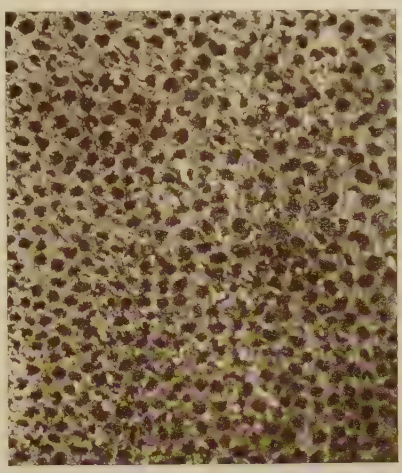

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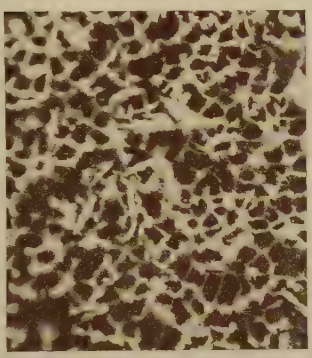

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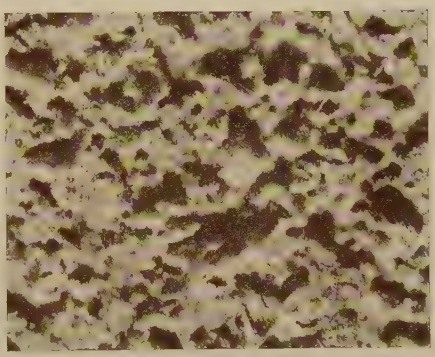

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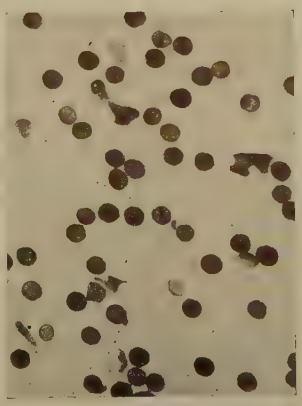

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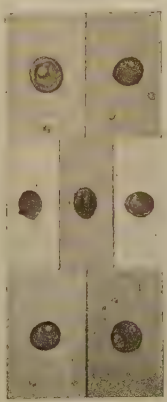

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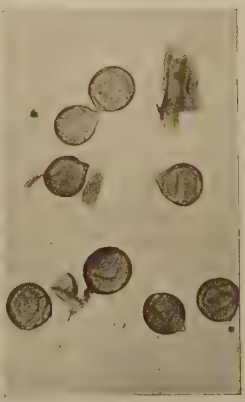

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